DECEMBER 29, 1958 Price 50 cents

R and D RESEARCH news issue DEVELOPMENT

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN RESEARCH AND DEVELOPMENT

PASSPORT TO TOMORROW

a study of R&D techniques

RESEARCH AND DEVELOPMENT 8 PROFILES

E B POWER
UNIVERSITY MICROFILMS IN
313 N 1 ST
ANN ARBOR MICH A
GS D

(Advertisement)

SPECIAL REPORTS ON FINISHING NON-FERROUS METALS

NUMBER I—Decorative, Corrosion-Resistant Finishing with Iridite

Chromate conversion coatings are well known and accepted throughout industry as an economical means of providing corrosion protection, a decorative finish or a good paint base for non-ferrous metals. However, continued developments are so rapid and widespread that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this digest of current information; to bring you up to date on the many ways in which you can combine salable appearance with durability in one finish at a competitive price advantage. Report II on paint base, corrosion-resistant finishes and Report III on chemically polished, corrosion-resistant finishes are available on request.

First, as a basis for this discussion, a "decorative" finish is considered as any chromate film that is used as a final finish in itself. It may be truly decorative in that its sole purpose is to enhance the beauty of the product. For example, a bright chrome-like finish or a pleasing bronze appearance are among the many effects that can be obtained. It may be functionally decorative in that it reduces reflectivity for camouflage purposes or provides a means of color-coding parts. But, in all cases, the Iridite films protect the metal against corrosive attack.

Iridite finishes are now available for all commercial forms of the more commonly used non-ferrous metals, including zinc, cadmium, aluminum, magnesium, silver, copper, brass and bronze. These films can produce a wide variety of pleasing appearances. The basic colors of the Iridite coatings are grouped below by metals.

ZINC and CADMIUM: Metallic bright, light iridescent, iridescent yellow, bronze, olive drab.

COPPER, BRASS, BRONZE: Metallic bright, yellow.

ALUMINUM ALLOYS: Clear, iridescent yellow, brown.

MAGNESIUM ALLOYS: Light brown, dark brown, black.

SILVER: Metallic bright.

In addition, many films can be modified by bleaching or by dyeing. Among the dye colors available are various shades of red, yellow, green, blue or black.

Depending upon the metal and the Iridite used, corrosion resistance of clear and bright films ranges from mild passivity to as high as 500 hours in salt-spray; on heavier dark films, salt-spray resistance ranges from approximately 100 to 1000 hours.

It is this combination of decorative and corrosion resistant properties that accounts for the widening use of Iridite finishes. For example, Iridites #4-73 and #4-75 (Cast-Zinc-Brite) make possible for the first time, a combination of lustrous chemical polishing of the as-cast surface of zinc die castings and good resistance to corrosion. Further, in many cases, sizeable savings in the cost of buffing and electroplating are realized.

WHAT IS IRIDITE®?

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

On many steel parts, a simple system of zinc or cadmium plate and bright Iridite is used instead of more costly electroplated finishes to provide a bright, decorative and protective finish with tremendous savings in material, equipment and labor.

In finishing aluminum, where corrosion resistance or paint adherence is the prime consideration, the aircraft industry has all but abandoned the anodizing process in favor of recently developed chromate conversion coatings, among them Iridite #14 and #14-2 (Al-Coat). These formulations and their method of application can be varied to retain the original metallic appearance while providing acceptable corrosion resistance, or to produce a fully colored brown finish that offers exceptional corrosion protection. Again, time and manpower savings are astounding—one company saved at least $15,000 a year on maintenance of racks alone and another $40,000 on materials and labor in only nine months. In addition, of course, hundreds of thousands of dollars are saved by eliminating the need for expenditures for generators, heating equipment and racks.

Iridites are widely approved under both Armed Services and industrial specifications because of performance, low cost and savings of materials and equipment.

In planning or designing, you should consider the many other characteristics of Iridite finishes which may enter into the specific problem. In addition to having decorative and protective functions, these chromate coatings form an excellent base for organic finishes and bonding compounds. They have low electrical resistance. Some can be soldered and welded. The Iridite film itself does not affect the dimensional stability of close tolerance parts.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product requires the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 E. Monument Street, Baltimore 5, Maryland.

starting next week . . .

FIVE STEPS TO *FASTER TECHNICAL READING*

A special series of articles designed to CUT YOUR READING TIME IN HALF

They were prepared exclusively for PRODUCT ENGINEERING by the Reading Laboratory, Inc. Expert teachers of high-speed, high-comprehension reading have written this six-lesson series summarizing the Laboratory's executive-training course to give you, in capsule form, a proven method for faster reading.

- The series will include speed tests and practical exercises chosen from articles in the same issues. You can immediately put the recommendations to work where they count most—in technical, on-the-job articles and reports.

LESSON I will be in the January 5 DESIGN issue.
watch for it.

coming next week . . .

the DESIGN issue

for January 5

FEATURING

- **How to plot high-temperature materials data**
  Carpet plotting speeds design job by reducing two sets of curves to one sheet.

- **A guide to static-pressure transducers**
  Diaphragm, bellows or bourdon pressure cells to sense pressure directly and continuously.

- **Mixed-flow impellers enter air-moving field**
  They outperform older types where pressures are too high for axial fans and too low for centrifugal blowers.

- **Foamed silicones give hi-temp insulation**
  Protect heat-sensitive parts up to 650 F—and higher in special cases.

- **How much force to deflect a spring sideways?**
  Formulas for force and stress when a side load deflects a vertically loaded spring.

- **Single-plate gear trains:**
  Eleven ways to mount shafts.

- **Powered spinning**
  Offers new design opportunities, larger, more complex, lower-cost parts.

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

R and D RESEARCH and DEVELOPMENT news edition

December 29, 1958 Vol. 29, No. 53

ALBERT HAUPTLI *publisher*

ELMER J TANGERMAN *editor*

ROBERT W CARSON *managing editor*
ROBERT E ABBOTT *senior associate editor*
RICHARD M KOFF *senior associate editor*

PAUL N ANDERSON *associate editor*
JOHN KOLB *associate editor*
NICHOLAS CHIRONIS *associate editor*
FORD R PARK *associate editor*
ROBERT S PRENTISS *associate editor*
ANNESTA R GARDNER *associate editor*
WILLIAM GILMAN *associate editor*
FRANKLIN D YEAPLE *associate editor*
JOSEPH J KELLEHER *associate editor*

BENEDICT A LEERBURGER, JR *assistant editor*
DOUGLAS C GREENWOOD *assistant editor*
RHYLLIS B SWEED *assistant editor*
DORA K MERRIS *assistant editor*
HERBERT KEE *assistant editor*
CHARLES J LYNCH *assistant editor*

FELIX GIORDANO *Detroit*
JACK MEYER *Los Angeles*
SETH PAYNE *Washington*

RICHARD E ROOMAN *art director*
E G LOADER *assistant art director*
ANGELA M GIACIN *assistant*

NORMA J VAN NESS *production supervisor*
LILLIAN M WITHAM *assistant*

JOSEPH KERR *consulting editor*
ROBERT E BRUCKNER *consulting editor*

DEXTER KEEZER *director, economics dept*
GEORGE B BRYANT, JR *Washington*
DONALD MacDONALD *Detroit*
WILLIAM G MELDRUM *Cleveland*
STEWART W RAMSEY *Chicago*
MARGARET RALSTON *San Francisco*
JOHN H KEARNEY *Los Angeles*
MICHAEL J MURPHY *Los Angeles*
RAY BLOOMBERG *Seattle*
B E BARNES *Atlanta*
KEMP ANDERSON, JR *Dallas*
JOHN WILHELM *editor, world news*
JOHN TUNSTALL *London*
JOHN SHINN *London*
ARTHUR ERIKSON *Paris*
GENE DI RAIMONDO *Milan*
RAYMOND SHAH *Zurich*
WILLIAM COUGHLIN *Moscow*
ONNIC M MARASHIAN *Beirut*
PETER WEAVER *Mexico City*
JOHN PEARSON *Caracas*
SILKE BRUECKLER *Bonn*
JIM MORRISON *Bonn*
SOL SANDERS *Tokyo*
JOHN YAMAGUCHI *Tokyo*

STANLEY J ALLING *associate publisher*
PHILIP G WEATHERBY *advertising sales manager*
P F PRITCHARD *manager, market research*
ROBERT C MATTOON *circulation manager*
C C KANE *reader service manager*
RUSSELL T DOUGLAS *business manager*

FEATURED:

PASSPORT TO TOMORROW'S NEW PRODUCTS. *A study of R & D departments in eight companies—their problems and solutions* 5

FIELDS OF INTEREST:

MATERIALS:

Urethane synthetic rubber tires for industrial trucks 28

Rubber-based adhesive stronger and more heat resistant 28

PROCESSES:

German welder boosts production output 26

Radiation better catalyst than ultrasonics 28

Lower-cost extrusions promised for aluminum 28

Polystyrene paper laminate is heat formed 28

ELECTRICAL:

Electrostatic separator for materials discrimination 27

Copper foil for electrical use is laminated on kraft paper and creped 27

DESIGN:

V-belt reinforcements standardizing on Dacron 27

Stop-light controller holds green light for speeding car 28

TEST:

Noise chamber for testing at 150 db 25

PERSONNEL:

Red engineering education keyed to Kremlin needs 25

DEPARTMENTS:

HORIZONS 2
SIGNIFICANT COMPONENTS 30
NEW LITERATURE 35
PUBLISHER'S POSTSCRIPT 36
FYI PERSONAL 37
WHY NOT R&D? 38

ABP DECEMBER 29, 1958 **Product Engineering** *A McGRAW-HILL PUBLICATION* Vol. 29, No. 53

PRODUCT ENGINEERING is published weekly,—with an additional Design Digest Issue in Mid-September, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE, 99-129 North Broadway, Albany 1, N. Y. See panel below for directions regarding subscription or change in address.

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W. 42nd St., New York 36, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice-President; L. Keith Goodrich, Vice-President and Treasurer; John J. Cooke, Secretary. Officers of the Publication Division: Nelson L. Bond, President; Harry L. Waddell, Senior Vice-President; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; A. R. Venezian, Vice-President and Circulation Coordinator.

Subscriptions are solicited only from executives, engineers and consultants engaged in the design or machinery and the other engineered products. **Position and company connection must be indicated on subscription orders. Send to address shown in box below.**

United States subscription rates for individuals in the field of the publication, $5.00 per year, single copies 50 cents; Canadian subscription $7 per year; foreign $25 per year, payable in advance. Second-class postage paid at Albany, N. Y. U.S.A.

©Copyrighted 1958 McGraw-Hill Publishing Company, Inc., all rights reserved.

PRODUCT ENGINEERING articles are indexed in both the **Industrial Arts Index** and the **Engineering Index.** PRODUCT ENGINEERING publishes its own semiannual index including the Design Digest Issue. Copies are obtainable on request to the Editor.

SUBSCRIPTIONS: Send subscription correspondence and change of address to Fulfillment Manager, PRODUCT ENGINEERING, 330 W. 42nd St., New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address giving old as well as new address, and including postal zone number if any. If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change of address to become effective.

Postmaster: Please send form 3579 to PRODUCT ENGINEERING, 330 W. 42nd St., New York 36.

PASSPORT TO TOMORROW

. . . a study of R & D techniques

Research and Development, just two words a score of years ago, are now so familiar that they've acquired alphabetical status as the familiar R & D. Surveys report $8.3 billion spent on R & D in 1958—the only curve in the book that kept on rising right through the recession. Of 118 major companies which combine components and materials in products, 95% mentioned research and development prominently in 1957 annual reports. A decade ago, the percentage wouldn't have been a tenth of that.

But surveys and curves don't tell the real story. What are the problems, as well as the potentialities, when a typical company sets out to do some R & D? Where does it fit in the organization? Do all new-product ideas come from R & D? How does "product planning" work out? Can R & D be close to sales and still work? What happens when research is centralized? What kinds of men are best for developing new products?

These and dozens of similar questions have been the subject of countless editorial discussions among Product Engineering staff members. But our impressions have been too vague, too colored by single exciting developments, to permit the broad picture to emerge—one that would be helpful to you.

What we needed was a planned series of visits by one man to a selected group of typical OEM companies—both large and small—having vigorous R & D activities. This man should talk to the engineers and scientists on the firing line, he should get his necktie caught in a model-shop lathe, trip over a jury-rigged piping system—even come home with grease on his best suit, but with a fistful of exposed film.

And that's just what we did. Ford Park, associate editor, and his new camera were turned loose in nearby New Jersey—where 9% of the national research budget is spent and where 14% of all R & D personnel work. Concentrating on companies doing work of maximum interest to Product Engineering readers, he visited all kinds of plants with all kinds of problems . . . realistic, down-to-earth problems, just like yours.

And he got the answers, too. The eight installations described in these pages suffered many of the pitfalls and setbacks natural to an uncertain project like company research. But these R & D setups solved their problems. They bypassed or pushed their way through the obstacles. They came out on the other side stronger, better organized, and more firmly convinced than ever of the value of research.

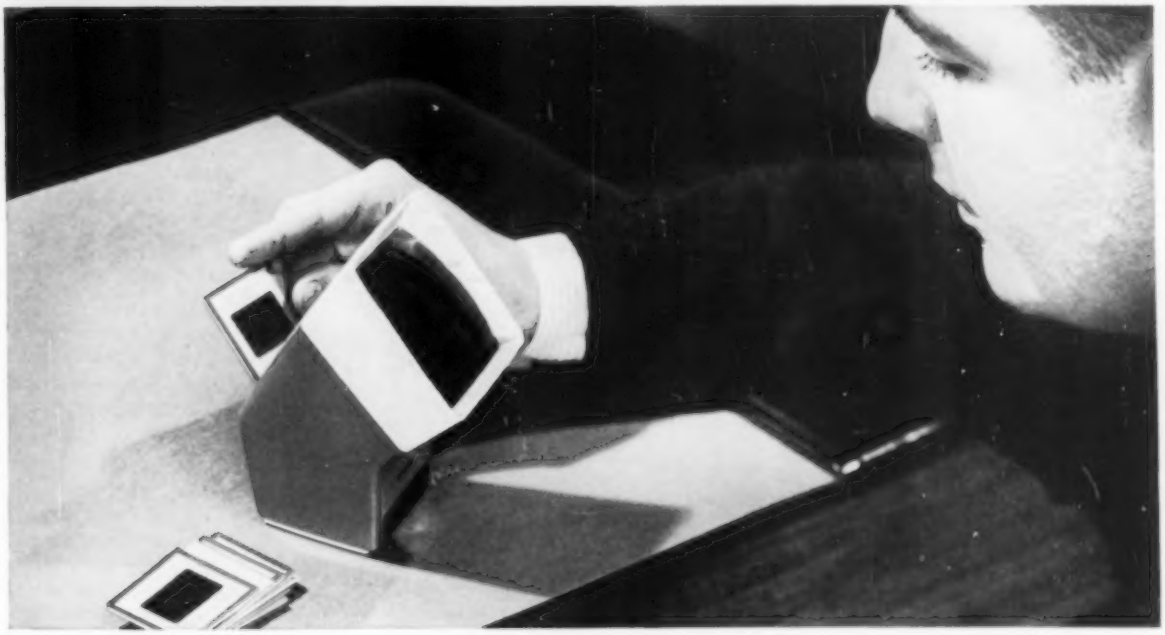
Here, then, is a profile in R & D—a gage against which you can evaluate your own activities, a stimulus to future activity—along with a series of pictures showing many previously unpublished products and techniques. Regardless of how large or small your company is, what design engineering problems you face, or what talents you employ —there's something of importance for you here.

It is your passport to tomorrow's new products and profits.

F. J. Langerman

CYANAMID

PLASTICS NEWSFRONT



ARGUS SLIDE VIEWER focuses on CYMAC® 400

A number of advantages made CYMAC 400 polymethylstyrene plastic ideal for the smartly designed case of the new Argus PreViewer II color slide viewer. CYMAC 400 resists heat and will not warp when the bulb is lighted for an extended period, or when the viewer is exposed to the hot sun in store windows. It resists stains and may be wiped clean. And it lends itself to attractive design in two tones of blue—color that won't chip off. CYMAC 400 is economically injection-molded for Argus by the Parts Division of Sylvania Electric Products, Inc.

POLAROID PICKS BEETLE® PLASTICS PARTS

Eleven parts, including the handsome pale gray and charcoal case of the new Polaroid Print Copier, are molded of BEETLE urea plastic. Selected for its hard, lustrous finish, durability and range of colors, BEETLE resists staining from oils, greases and common chemicals. Parts are compression-molded by G. M. Laboratories for the Polaroid Corporation. Used in conjunction with the Polaroid Land Camera, the Copier delivers finished prints in 60 seconds.

For the plastic that will best meet the requirements of your particular application, call or write the Cyanamid representative nearest you.

AMERICAN CYANAMID COMPANY
PLASTICS AND RESINS DIVISION
40A Rockefeller Plaza, New York 20, N. Y.

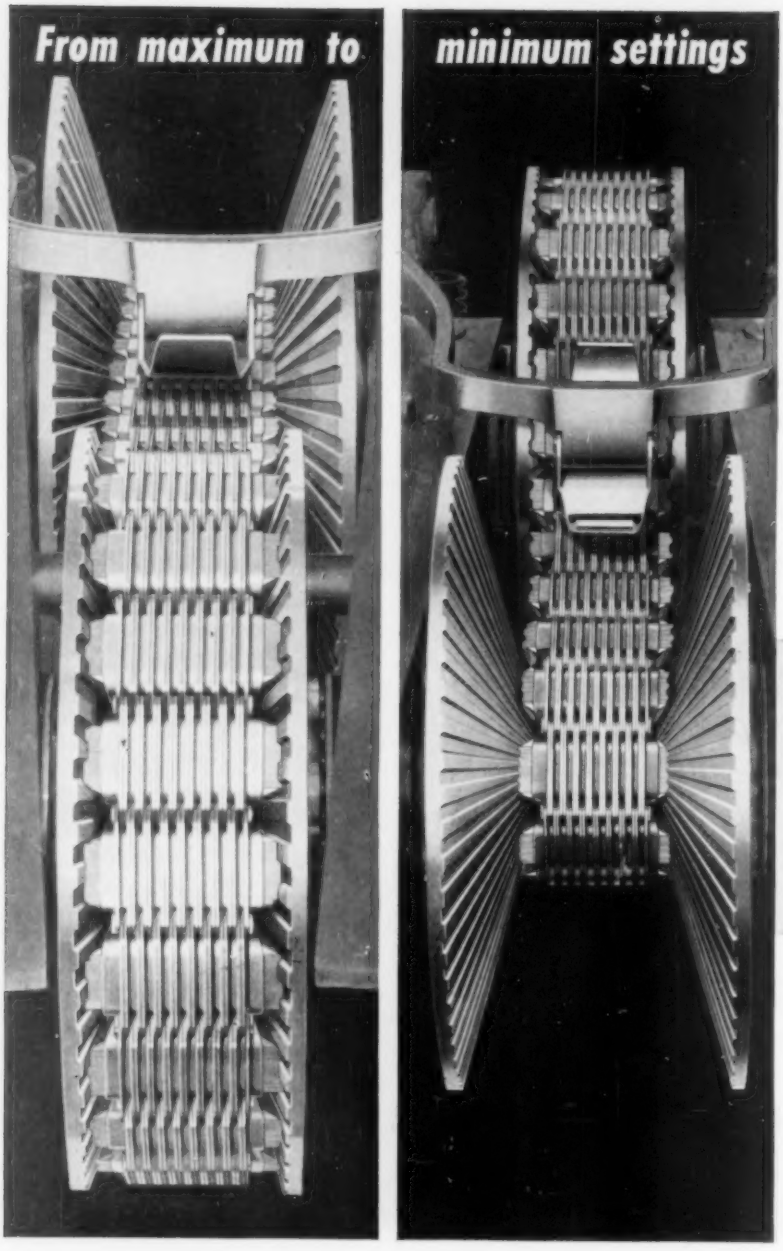
In Canada: Cyanamid of Canada Limited, Montreal and Toronto

Offices in: Boston • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Detroit
Los Angeles • Minneapolis • NewYork • Oakland • Philadelphia • St.Louis • Seattle

CYANAMID Plastics and Resins Division

For positive, accurate speed control

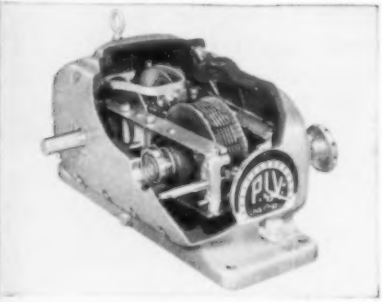
...there's nothing like P.I.V.



VARIABLE from top speed to minimum speed with no steps, no stops in between. That's Link-Belt P.I.V.—the *only* chain-driven variable speed drive. Teeth—not tension—permit instant ratio changes with no loss of speed, regardless of load conditions.

Slippage? Not a chance—P.I.V.'s chain-to-wheel grip is positive as a gear. In fact, this is industry's most accurate, most reliable mechanical variable speed drive.

Your nearby Link-Belt office will assist you in applying P.I.V. to meet your variable speed requirements. Call today or write for P.I.V. Book 2274 containing complete information on drives from ½ to 25 hp.



HOW P.I.V. WORKS. Exclusive self-tooth-forming chain of P.I.V. consists of packs of free-sliding steel slats which serve as teeth. Chain grips beveled grooves on pairs of conical wheels located on input and output shafts. Speeds are changed by varying the effective diameters of the wheels, as shown at left.

P.I.V. LINK-BELT
VARIABLE SPEED DRIVE

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.815-A

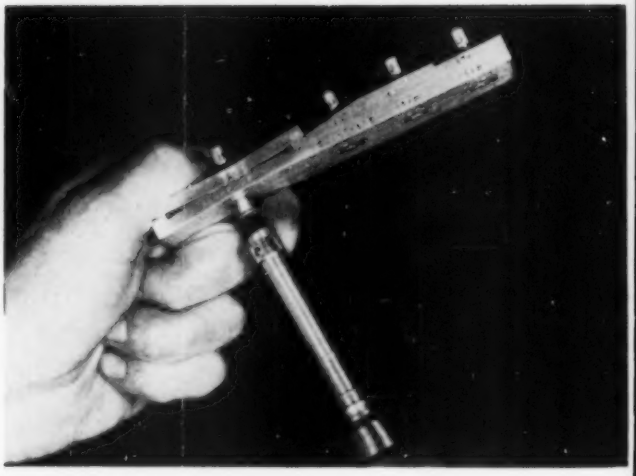
PASSPORT TO TOMORROW'S NEW PRODUCTS

FORD R PARK, Associate Editor

Why R & D? How is it done? What are the results? To supplement general statistics and surveys previously available, and to answer the designer's specific questions, we have selected eight typical companies and studied their R & D operations at close range. These companies, both large and small, differ from each other in objective, origin, personnel, setup, size and product and in financial commitment to R & D: median expenditure for 7 of the 8 companies was nearly 5% of sales, with the spread running from 2% to 8%. (The exception, Reaction Motors, is well above 50% because of its interest in contractual research). These companies have in common, however, a firm belief in the value of research and development. In how they solved their problems—as shown in these profiles in R & D—are contained specific ideas for you.

8 Profiles in R & D—a quick survey

	Company & Location of R & D	Product Area	Employment Total	Employment R & D	1957 Sales Millions of dollars	See Page:
1	Elastic Stopnut Corp of America; Union, NJ	Threaded fasteners	1150	34	28.7	6
2	Eclipse-Pioneer Div, Bendix Aviation Corp; Teterboro, NJ	Flight control devices	7950	180	82.5	8
3	US Rubber Co; Wayne, NJ	Rubber & plastics	40,000	2000	873.6	10
4	Monroe Calculating Machine Co, Div Litton Industries; Orange, NJ	Business machines	980	>200	>45.0	12
5	Reaction Motors, Div Thiokol Chemical Corp; Denville, NJ	Rocket engines	1780	384	24.4	14
6	Austenal Inc, Div Howe Sounds Inc; Dover, NJ	Investment castings	1600	65	>10.0	16
7	Rubber & Asbestos Corp; Bloomfield, NJ	Industrial adhesives	200	18	>5.0	20
8	Walter Kidde & Co; Belleville, NJ	Pneumatic systems	1620	300	38.1	22



PRODUCT PLANNING puts design on the right road

By scanning the markets and stating the problem, product planners at Elastic Stopnut Corporation of America free R & D for creative fastener design.

It's simple if you keep your eyes open—you can see that a war boom will not last forever. That's what Elastic Stopnut Corp of America did, back in 1954, when it moved to revitalize its line of threaded fasteners—by reorganizing its engineering and R & D activity around a newly created product-planning department. The result is that ESNA is enjoying today more profits than many another established company that thought defense prosperity might keep right on.

The problem is a familiar one. In periods of national crisis like Korea, defense business is good. The profit picture improves for established companies as they multiply production of their standard products to meet the military need. But meanwhile their long-range prospects go aglimmering . . . and bright new competitors are converting new concepts into products that will step boldly into post-crisis competition.

ESNA refused to let prosperity sap its vitality. And its product planning has paid off: In the three fiscal years since 1954, 25% of the company's dollar volume has resulted from products that didn't exist in that year. And each year's percentage has risen, too.

Product planning, a management "gimmick" to many, can work such magic if tailored to company needs and characteristics. At ESNA, this activity is located under Sales—which is dominant. Three basic objectives of the group are described by Jim Duke, product-planning manager and former flutter expert at United Aircraft Co: "We review the product line to keep it competitive, we maintain the image of ESNA as a quality producer by a vigorous service engineering program, and we keep development moving on new fasteners that anticipate the market."

New fastener concepts are not as difficult to come by as might be supposed. However, in addition to the usual sources—sales contacts, service-engineering discussions with customers, and the engineering department—ESNA taps two others: individual inventors outside the company, and inventive engineers employed by ESNA's customers. "Inventors are like hoboes in a way," says Duke. "They have an uncanny knack for passing the word that a company is interested in outside inventions. From these men and their ideas, however unusual, we uncover many novel —even brilliant—fastener ideas. With customers, we work through their patent departments to demonstrate we are willing to invest money in the development of ideas dreamed up by their people—ideas the customers don't wish to commercialize themselves. We often advertise for ideas in business journals commonly read by inventor types."

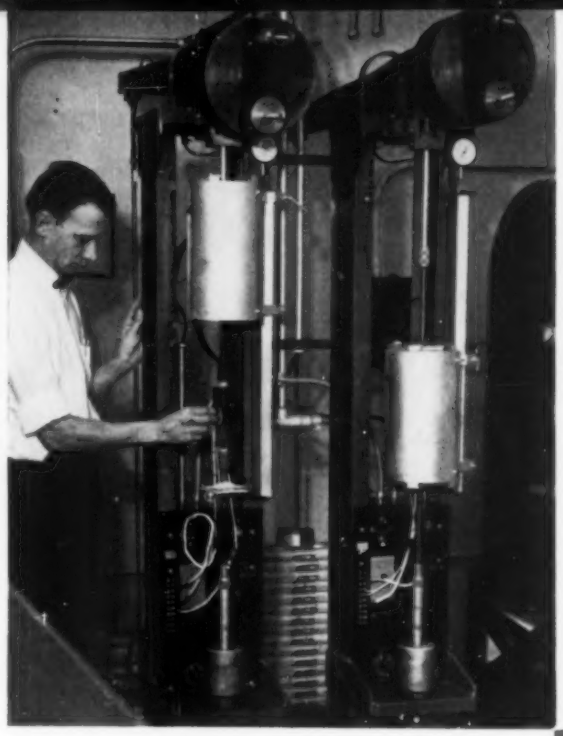
Whatever the idea source, Product Planning screens them all, selects those for further development, and turns them over to Engineering for detailed design. When the idea merely states a need—for a fastener that doesn't yet exist—Product Planning draws up specifications for the fastener, and asks Engineering for a specific design. This leads to more original solutions, according to Charles Faroni, ESNA chief design engineer, who manages the 45 men in ESNA's Engineering and Research group: "The man who is assigned the project can let his mind roam—something he couldn't do if forced to work closely with the customer. For example, the customer might be biased in favor of one installation method—say air hammers. This bias can quickly rub off on our designer, and stultify his thinking. Of course, Product Planning has to state the problem carefully, and sometimes we have to live with customer bias of this sort. Ideally, we try to make each solution as broadly applicable as possible to widen our markets. With Product Planning preparing problem specs, we think we get a greater number of hits."

Faroni feels strongly about individual invention. "Top-flight new fasteners are invariably the work of a single probing mind. You've got to pick the right man, though; give him responsibility—and backing from your experts in allied fields. Design committees are good for only one thing—evaluation of the final product."

Where the designer hits a problem that takes research to resolve, a subproject within the department is initiated, usually with Product Planning's concurrence. A four-man team, two mechanical engineers plus two technicians, takes on the problem—along with the continuing research they perform on basic problems in threaded fasteners like thread form, surface finish, creep and relaxation, effect of vi-

New blind bolt . . .

just out of ESNA R & D is shown here doing three difficult jobs. Left-hand bolt joins two sheets, one of which is bowed by fastener; in the center, back sheet is tapered 10°; at right, sheets are of different thicknesses: max grip is 0.406 in.; min grip is 0.344 in. Joints made with new fastener have a continuously linear force-deflection characteristic because the bolt is designed to fill the opening completely at installation—a desirable feature when creep loading is a factor.



Bolt-relaxation test . . .

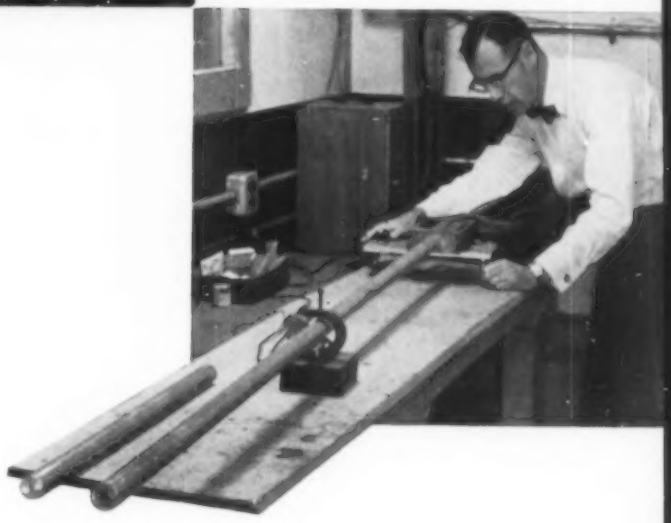
like the one being set up here, tells researchers how much clamping action is lost when a particular bolt design is subjected to elevated temperature. To obtain relaxation data, the specimen is loaded and its initial deflection measured. The bolt is then heated to test temperature and, as the specimen relaxes (or extends), loading is reduced to maintain initial deflection. Bolt relaxation is the difference between length of bolt before and after test. This is, in effect, a creep test with a variable creep rate.

bration and so on. These basic programs are kept vital by twice-yearly conferences between E&R and Product Planning. Here, trends are examined and research kept pointed to areas where problems in design can be expected in a few years.

Solution of the design problem posed by Product Planning takes the form of detailed drawings plus a few samples turned out in the model shop. While Product Planning is having the new fastener cost-analyzed in Manufacturing, the prototypes may be taken to a selected customer for field evaluation. "Here's where you can tip your hand to your competitor," says Duke, "but often you have to get a field reaction before deciding to proceed. This is particularly true when the fastener concept is radically new. It's a risk that has to be run."

Service engineering, in the ESNA approach, is a vital part of Product Planning. This function modifies existing fasteners for special applications, checks on mis-use of company products, helps customers specify the right fastener with the company line. This group does its work within E&R, but maintains liaison with the customer through Product Planning. "This way," explains Duke, "we have feedback in the system which helps us spot fastener trends and thus anticipate future markets. We can sense soft spots in our current line easier, too."

Organizationally, the product-planning function can be elegant or simple. It can control everything from idea flow to product testing. "Being a busybody is the besetting sin of a product-planning engineer," states Duke. "The cure for this is to start simply with a small staff. We have three here at ESNA. This way we're so busy doing our own work, we haven't got time to do somebody else's." Duke's favorite definition of Product Planning's responsibility: "To conceive, successfully develop, and profitably market new products that fit ESNA's growth and profit goals." ■



Hi-fi shaker . . .

gets final adjustment before vibrating threaded fastener at jet-engine frequency. Fastener is threaded into free end of aluminum bar, which is freely supported at its midpoint. Bar length is made one-half the desired frequency wavelength so the midpoint becomes a nodal point for longitudinal vibration induced at one end by an eddy-current generator. Current induced in the bar produces a magnetic field which is alternately attracted and repelled by a permanent magnetic field surrounding the end of the bar—thus alternately stretching and compressing it longitudinally. Vibration is started with a random noise signal, but a contact microphone at the nodal point picks up the resonant harmonic as the bar swells and contracts radially due to Poisson effect. This signal is then fed back to the power amplifier—correcting input to the bar to get full resonant vibration. A fastener is tested at various frequencies from 600 to 15,000 cps, using a different bar length for each test frequency. Criterion of failure is loosening—which immediately damps out the vibration.

FOR A COMPLEX PROJECT

. . . These Three Remedies

Staff planning, built-in R & D, and a design-review board —these all help the Eclipse-Pioneer Div of Bendix Aviation design reliable flight-control systems on schedule.

The assignment concerned a pistol-hot new plane—designing a sophisticated instrumentation and automatic-control system for Convair's B-58 Hustler.

And how do the 725 engineers look back on that project at the Eclipse-Pioneer Div of Bendix Aviation Corp?—"Just another black-box job that needed some headshrinking."

But to higher management, that kind of complexity can induce an R & D nightmare. It needn't. Eclipse-Pioneer has devised several techniques to organize and keep tabs on such projects—to insure that the delivered hardware will perform reliably and right on the nose of specifications. Let's look at some of these methods that might keep your own product-development program out of trouble.

For the flight-control systems that are E-P's specialty, the engineering department designs its own data-handling devices—electromechanical devices for data sensing, transmission, computing, display, guidance and control. A good example is the Air Data Computer—fireplug-size package that takes the four basic environmental inputs—impact pressure, static pressure, air temperature and angle of attack—then operates on this data to get 14 variables from Mach number to air density, and feeds the result to eight significant airplane functions—from fire control to automatic pilot.

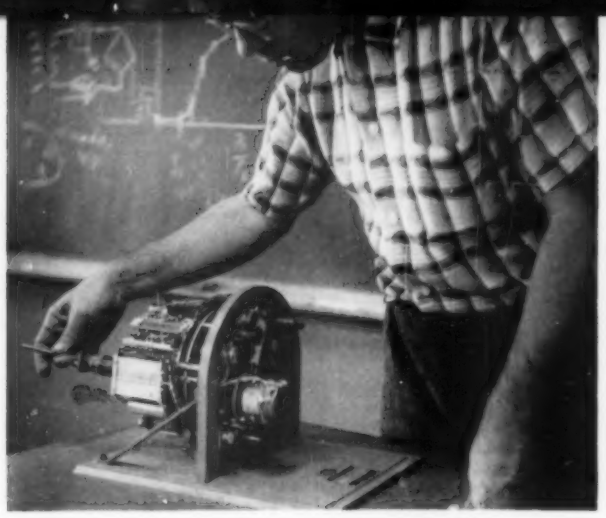
For products like this, which evolve as aircraft design poses such increasingly difficult control problems as transonic flight, E-P has organized four separate R & D activities—one in each of the four basic engineering groups: systems, mechanical instruments, electrical instruments, and support equipment. Thus R & D effort becomes an integral part of any contract, and the company's new products evolve as the project progresses.

Estimating the manhours to solve a tough systems problem is the place where an outfit like Eclipse-Pioneer can lose its shirt—unless special care is taken before the proposal is submitted. E-P attempts to identify and define the sub-jobs that need doing in a thorough "statement of task," breaking them down by four effort areas: engineering, lab, drafting and shop. In a current redesign study on the B-58 Hustler autopilot and power-control system, for example, the statement of task extended for 24 pages and covered more than 50 separate studies. Prepared with the task statement are projections of manweeks required in each of the four categories. Jobs easily overlooked are included also: too often manhours consumed by programming, liaison with the contractor, drawing changes, progress report writing are blithely assumed to be part of overhead until the cost reports start rolling. By then it's too late.

Balancing current workload against available manpower is a monitoring function assigned to a small staff group called "central project planning." Taking the accumulated project charges in manhours, the current census on each project (many engineers shift about according to need), and the original proposal manpower projections, this group tabulates these data by departments. Breakdown is by function—engineering, drafting, lab, or shop. Excessive overtime buildup is easily spotted by comparing the previous month's charges with the capacity of the number of engineers reported for a given department if they were working a normal week. A simple bar chart is then prepared for each of the four functions, with the excess of workload over capacity shaded to catch the eye. By carrying the charts four months ahead, management can see at a glance the present problem and its immediate effects.

For estimating current progress, E-P uses a novel scheme to supplement the usual progress reports of the project managers. "We count completed drawings," says Jim Bevins, director of engineering. "Whether the project is R & D or straight engineering, counting tangible evidence of work done is much better than relying on the project manager's estimate of how far along the job is percentagewise. Toward the end, projects have a funny way of staying 90% complete weeks on end. Sometimes the number of parts manufactured is used. Once you've tried this technique a few times, the normal pattern of progress emerges and correlation on future jobs is easy."

Forecasting workload is a bit more sticky because both current backlog and outstanding proposals are factors. Four times a year, the E-P budget director prepares a "forecast of engineering labor" that consists mostly of bar charts on the four engineering specialty departments—systems, mechanical instruments, electrical instruments, and support equipment—and on the four combined. One section of the forecast covers present backlog, with estimates reaching six months aread. Potential new business makes up another section, with outstanding proposals summarized as to department and



Radiation counts molecules . . .

in this new pressure-sensing element being inserted into an air-data computer. Now designed for static pressure to get altitude, the counter can be modified to sense total pressure and hence air speed. Irradiation of the gas sample induces a current proportional to the number of air molecules per cu. in. Basic R & D trick—not revealed by Eclipse-Pioneer—is picking off the voltage drop when this minute current is passed through a resistor. Simplicity and extended range are the main advantages over aneroid-type sensors—where diaphragm balance is easily upset by vibration, and hysteresis effects cause trouble. With no diaphragm, the new sensor has good accuracy and reliability to altitudes well over 50 miles.

amount—and a prospect rating of "execellent, good, or poor" listed for each. Picking only the projects rated "excellent"—to be conservative—the planners then prepare a rough manhour breakdown for 12 months ahead, again in chart form. Combining the backlog and new-business charts for six months ahead forms the final section—with a reference line sketched in to indicate current capacity in each department. A 2-page, easy-reading summary completes the forecast.

Once a proposal becomes a contract, and development work begins, the problem of design quality and reliability becomes a thorny one. The later an engineering boner is discovered, the more expense is incurred correcting it. As a step to better design, Paul Bechberger, assistant director of engineering, devised the Design Review Board. Formidable as it sounds, the idea is simplicity itself. Says Bechberger: "It's impossible for a project engineer to be completely up to date in all the engineering disciplines that enter into the design of our products. So we created 60 technical categories and selected experts in each as members of the review board. These men are responsible for keeping up with the state-of-the-art in their field. At the layout stage, the needed specialists meet with the project engineer and advise him on the adequacy of the proposed design—checking all phases: performance, cost and reliability."

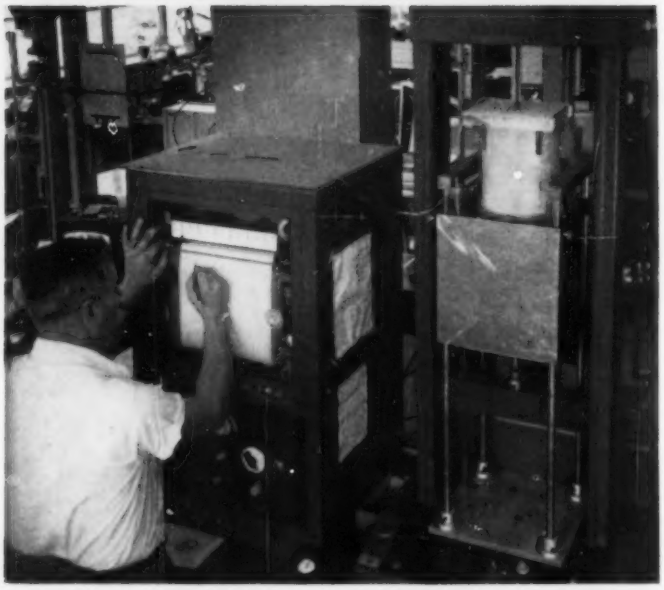
From its inception, the guiding philosophy has been to keep full design responsibility and initiative with the engineer responsible. Recommendations of the board are in form of advice—not binding on the designer. Minutes of the meeting, made for the record, serve as a reminder for the designer when considering changes. "Pride was a problem at first," concedes Bechberger, "Project engineers were leery of exposing their brainchildren to criticism from men who didn't have ultimate design responsibility. Soon, though, everybody warmed up and now designers and specialists do a lot more consulting early in the game—and information exchange between departments has picked up too." There are other, more tangible results: serious design mistakes have gone down almost 70% and delivery dates on some projects have improved by as much as 18 months. In addition, the checklists made up by the specialists for use at DRB meetings are now used during design: They reflect the latest experience factors and state of the art. ■

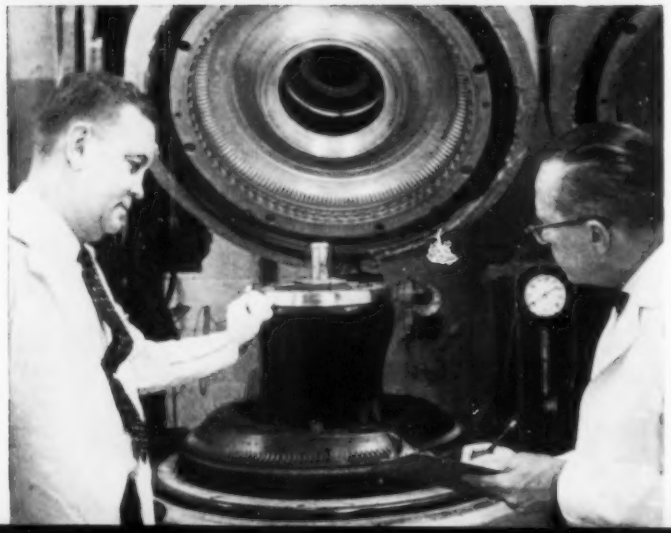
What's wrong . . .

closely as his idea for improving a new pressure-transducer design is batted around the table. Design Review Board meetings like this bring specialty men and project engineers together; spot bugs before the design is frozen. Since the program was adopted in 1956, E-P has averaged one such meeting every two days, with 14 men working over new-product designs for one hour.

Flight control by analogy . . .

is planned by computer engineers. Analog computer helps research a new system on paper before key design decisions are made. Another plus advantage: As prototype parts of the system are built, they can replace their own analogs in the computer setup. Before long, the entire control system is being "flown" on the ground—as was done for the B-58 Hustler flight-control system designed by E-P.





U.S. RUBBER 3 WAYNE, N.J.

HIP

Why not this way? . . .

asks a chemist from one of US Rubber's operating divisions during a two-day technical symposium at the Research Center. His challenge was triggered by the paper just presented by scientist at the rostrum. Carefully planned by the host department, these symposia are modelled after technical society meetings. The papers presented, and the discussion they generate, form a vital communication link and source of ideas.

Ready, get set, go . . .

Researcher in materials-testing lab will record tensile stress-strain curve at high temperature for new synthetic-rubber formulation. Test oven (upper right) holds material at temperature within $\pm 0.1^\circ$ C. Specimen is rubber ring punched out of sheet stock, rather than traditional tensile coupon. Ring specimen is stretched between pivoted pulleys —which rotate slowly during pull to equalize strain.

Rubber helps vulcanize rubber . . .

in this lab-size version of bladder-type tire molder. Inner bag carries hot water under pressure to force tire casing against heated tread mold, and help vulcanize the tire. Latest bag material is US Rubber's resin-cured butyl HTB. Replacing sulfur as vulcanizing agent jumps max continuous operating temperature of butyl rubber to 350° F and improves resistance to heat-aging.

BOOTS for the river of words

Technical symposia and resident scientists are just two techniques at US Rubber that speed communication between research center and operating divisions, and spot new-product ideas.

Most technical people these days wade hip-deep in a river of words flowing from a fast-paced technology and highly developed communications industry. And amid the swirl of ideas clamoring for attention, those of the fellow in the next office or out in the plant are often overlooked.

How to help the new idea reach the surface and life-giving encouragement is a major problem for US Rubber Co, with a central research laboratory in New Jersey and operating plants in 18 states. Dr. Lee White, director of Research and Development, puts it this way:

"The scientist with his feel for the beginnings of physical truth must, of necessity, be the real origin of new-product ideas. Effective technical communication all through the company should make a maximum number of clues available to him. This, I feel, is the main organizational goal of an R & D department. This transcends massive budgets, sparkling new buildings and equipment, university atmospheres—the usual panoply of American R & D."

To implement this philosophy, Dr. White has adopted several rather unusual techniques—all based on primarily oral rather than written communication among company scientists and engineers.

Resident scientists, usually two or more from each of the operating divisions, do research at the central laboratory on their own division's problems. "Cross-fertilization of ideas is the result," points out White. "The division scientist gets a crack at more basic work than he might on his home ground with the continual crises popping up—and the Center's staff scientists get to appreciate some of the practical aspects of materials research. Naturally, more equipment is available—but the chief benefit to the resident scientists is the opportunity they have for mixing in a wider ranging technical community."

Technical symposia modelled after technical society meetings—with formal agenda, papers, comment and discussion—occur throughout the year. Although the meetings are organized under the watchful eye of Dr. Tom Wilson, manager of the Center, he is quick to point out the do-it-yourself aspects of the idea: "Each department at the Center organizes its own symposium. For example, when it's the turn of the Synthetic Rubber Research group, they work up an agenda in cooperation with the chosen operating division, covering latest advances in that area. Papers may come from either the Center or the division, which sends a technical team for the meeting."

Over the 2-to-3 day period, it's not uncommon for higher R & D management to stay away from the sessions completely—a step which often results in a freer exchange of thinking. Competition among departments is keen; each wants to outdo the others in bringing off a high-quality, fruitful symposium.

Beyond the organized exchange of ideas, visiting division men can move around the laboratory discussing their problems with coworkers in other departments. This way, the image of the Center as merely a giant service group is quickly dispelled.

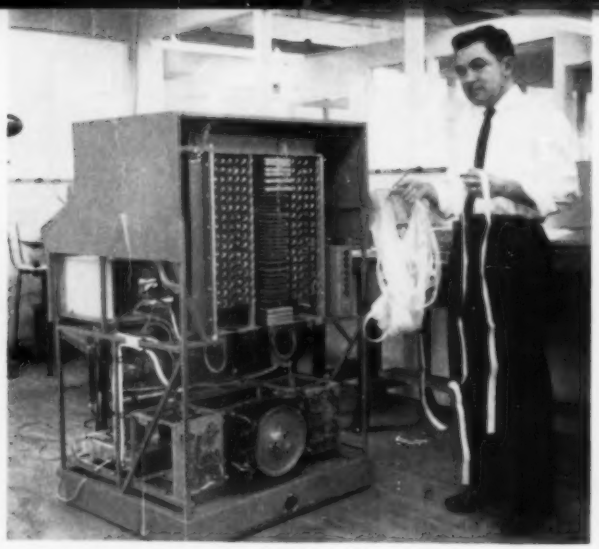
Division-manager conferences with the various R & D department heads maintain communication at a slightly higher level. Three times a year, a division manager and his top staff are briefed at the center by each R & D group on activities that might relate to division problems. The resident scientists assigned to the Center by the division sit in on these presentations, which are usually finished in one day of intensive work.

Rotating departmental presentations within the Research Center itself stimulates idea interchange across non-related groups. For two days each month, one group—say, synthetic fiber and radiation research—will talk about its progress to the managers of other groups. "Each group explains its work about once a year," explains Dr. White, "and preparation is very thorough, with each trying to make the best showing. We find that competition of this sort helps us spot all sorts of new ideas, many with considerable market potential."

Commercial and Operations Research is a four-man team of senior scientists reporting to the director on developments that show market potential. With direct access to all divisional marketing data, this group can quickly evaluate a new material or process, and recommend further exploitation. According to White: "These men try to pick those developments that most closely match division needs. A new plastic may be evolved at the Research Center or at the divisions, which do substantial research themselves. Whatever the source, this group insures that no significant developments lie fallow for want of evaluation from the market slant. One method of communication upward, incidentally, is via the Research division, which sends a technical team for the meeting." men." ■

WHICH PRODUCT DESIGN for lowest cost reliability?

R & D at Monroe Calculating Machine Co picks the right one with a new products evaluation committee, engineer "brainwashing," design reports —and doesn't forget life tests on every component.



Five and dime computer . . .
is the latest Monroe special-purpose business machine. W T Grant Co wanted to sort out sales from 100 departments in over 600 stores. Here, a development engineer holds the punched-tape record from just one cash register from one of these stores on a busy day. New machine, called Distributape by Monroe, summarizes these sales on the 6-ft tape shown at right, which later feeds to a mechanical printer for a readable record. Scanning photoelectrically at speeds up to 200 characters/sec, the computer sorts out 1000 transactions/minute, will cover sales for 25 stores in less than 8 hr.

If there is one outstanding devil besetting designers of business machines, it is how to get reliability without boosting costs beyond the average businessman's budget. Such machines are not missiles (where reliability must be tops and cost is secondary), nor are they TV sets (where an occasional picture jump is tolerable because cost is low). But Monroe Calculating Machine Co a division of Litton Industries has bridged this design chasm with R & D methods bringing broadened markets and increased sales.

It's all part of a product-expansion program. Monroe has long built mechanical accounting and calculating machines. It is now also producing the latest in common-language machines.

To handle research and development for about $45 million of annual sales, Monroe has created two staffs: mechanical research, and electronic research. Actually, there is some overlap between them, but the break is a natural one—with mechanical research handling essentially low-speed designs, and electronics taking the high-speed problems. Arithmetic operations taking place in microseconds fall in the high-speed category, according to Monroe.

Because there is a natural tendency in companies like Monroe for even R & D departments to become embroiled in day-to-day problems, both mechanical and electronics research have small groups responsible for advanced thinking. In machanical research, it's called "advanced research and development;" in electronics, the label is "advanced planning." Both, however, have highly creative engineers intimately familiar with the number-handling problems of modern business.

With their knowledge of market needs and the intricacies of system logic, these applications engineers research a new machine on paper—trying to make it do as many forseeable jobs as possible. This adds sales flexibility, but runs head-on into the project engineer's responsibility: low cost and reliability. These two engineering groups resolve their differences, and come up with a proposal fully documented as to approach, probable cost, design obstacles to be overcome, and a rough market potential.

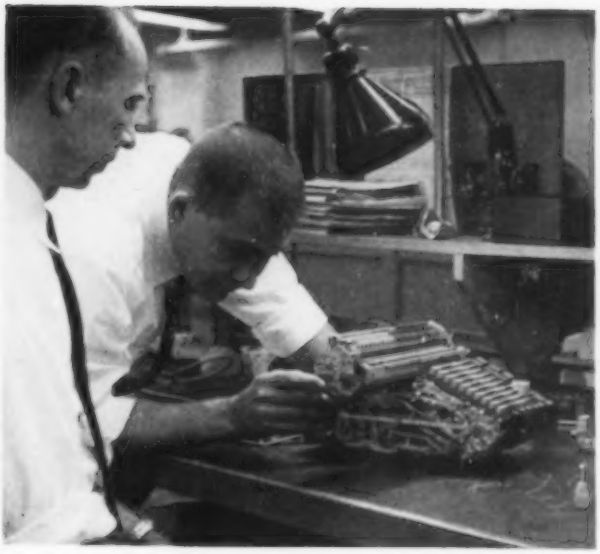
This kind of teamwork requires men with a creative and inventive turn of mind. William Burkhart, manager of electronic research, defines this mentality: "I want a man who can take my solution of the problem—on which I may have spent a day's thinking—and come up with a demonstrably better way of doing it after a few weeks or months of study. If he comes back and says my idea is best, he'd better be sure he's looked hard at all the alternatives." Put another way by Nat Wales, manager of the mechanical department's advanced research group: "A mature inventor is one who can have his idea killed gracefully, and still have the tenacity of mind to come up with a better one."

One way to encourage creative thinking is to give the engineer time of his own to work on projects dear to his heart. Monroe allows time for this, and delicately suggests the work have some relation to Monroe's problems. Explains Burkhart, "We hope our men are enthusiastic enough about Monroe's product to keep their projects related to it. Thus far it's worked out fine."

Capping the initial efforts of either research group on a rough proposal for a new machine is a formal presentation of the idea to a new-products evaluation committee.

On the bench . . .

new memory-drum coatings, magnetic heads and circuits are researched before life-testing. On each such computer building-block, Monroe R & D engineers must prepare a design report justifying each part used, its purpose and limits of operation. This step keeps the design engineer from misapplying the newly researched component, and adds to product reliability.



Why did it fail? . . .

Development engineers roll up their sleeves to investigate a prototype desk-calculator mechanism. Here, a mechanical action was timed too closely in a multiplication controller mechanism.

Chaired by the president, and serving to advise him in reaching a decision, the committee has these members: product planning manager, marketing manager, controller, both research managers, production manager, and the heads of sales for both accounting and calculating machines. Here, the scrutiny is intense—and many a proposal has failed to reach the design stage and full project status because of inadequate preparation for such debate. Meetings are held only when requested by R & D to consider a specific proposal, or called by the chairman to talk out a new market need that looks promising for Monroe.

Getting new engineers to recognize and accept a different set of objectives is a big obstacle in the struggle for low-cost quality products. Habits and attitudes learned in one industry are not always useful in another, and are hard to shake—even among highly creative men. Says Burkhart: "We have to 'brainwash' our incoming engineers: missile men must be more cost conscious, TV and industrial-electronics men must think more about reliability. Take switches for instance. We had a new man rate one switch much higher than another because, on life test, it fluttered a bit but kept working—while the other switch stopped cold. It took a while to convince him that, for us, it's better to have the computer not work at all than have it make one mistake a week."

Reliability in components—whether linkages or circuits—is the second most critical step to quality, after engineer reliability has been achieved. Business-data processing equipment, both mechanical and electronic, depends heavily on the building-block concept in design. In the electronics research department, for example, new circuits are researched by a separate group which takes advice from Advanced Planning on the kinds of tricks business machines must perform five years hence. For top reliability at minimum cost, the designer of a new circuit must justify—in a written report—all the parts used therein. For each part, he must state its purpose and limits of operation. Purposes and limits for the assembled circuit must be clearly set out, too, so the project engineer will know precisely how far he can push the new building block when designing a new machine. Here, life testing for at least one year makes statement of performance levels more than paper estimates.

But life testing doesn't solve all reliability problems. Burkhart adds these words of caution: "Once a few basic building blocks have proved out on test, the research engineer is tempted to assume that the parts used in those blocks are the ones to use in all future designs, even though conditions may be slightly different. By insisting that part-performance limits be established and reported, the engineer can quickly reexamine each part to see if it fits the new situation. He then goes on record with his choice as before. This system may seem rigid, but business machines are intricate and it's easy to make wrong choices if the natural instinct to build closely on precedent is followed indiscriminately."

As a final thrust in the quality vs low-cost battle, Monroe tries to encourage its R & D men to exchange ideas, be critical of their own designs, and to be receptive to constructive criticism from others. Advises Burkhart: "Try writing a final project report, and you'll find all sorts of places where you could have done a better job!" ■

Yesterday . . .

rocket R & D was in a corn field in the hills of New Jersey—members of the American Rocket Society test a 1940 rocket engine of about 200-lb thrust (unaware that the Germans were already flying experimental ballistic missiles with much more powerful engines). Four of these early enthusiasts went on to form Reaction Motors Inc, with US Navy encouragement.

A COMPANY GROWS . . . and splits its R & D

Reaction Motors had to pioneer its own way with rocket engines. That's over now—the company has gone on to separate research from development—and mobilizes planning teams who can see tomorrow's rocket needs while meeting the sales demands of today.

Behind the Space Age rumble and roar of rocket engines in the concrete test stands at Lake Denmark, NJ, lies a down-to-earth story of how the Reaction Motors Div of Thiokol Corp marshalls brainpower and sells it at a profit. The story shows adaptability.

Reaction Motors' successful growth came from pioneering rocket-engine designs for the armed services during a period of technical adolescence—a period of many imponderables and few guideposts. But now the picture is changing—and with it Reaction Motors' method of attack. It can focus on its long-range goal—building rocket hardware in quantity.

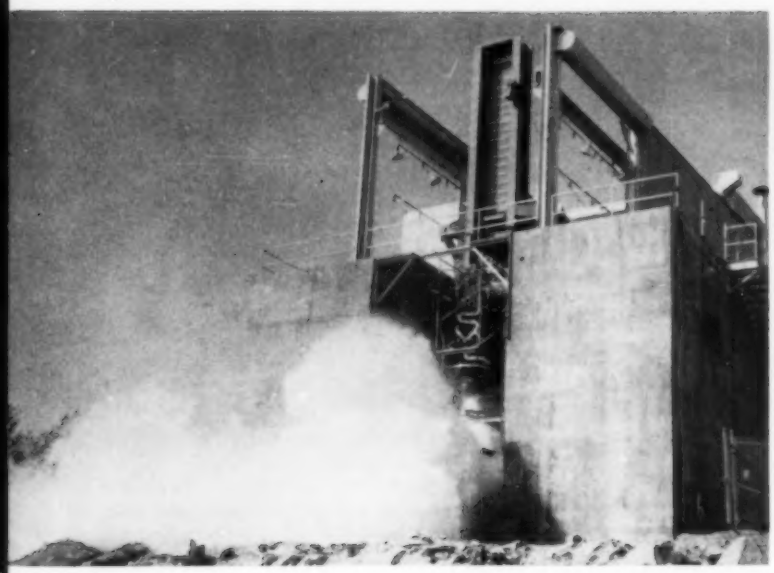
This is because the propulsion industry has matured; rocket engines can be designed and built to customer specifications in reasonable time and at reasonable cost. Engine companies like Reaction thus become less dependent on the ability to conduct research as an integral part of an engine-development contract. At Reaction Motors, this has led to redefining the research function and its relation to engine development.

Here are some of the techniques devised to implement this reorganization within the company's traditional income pattern of contractual R & D:

Technical activity is separated into two departments, Research and Engineering. The guiding philosophy is that research and project-development work differ in their controlling criteria—time and breadth of study of a problem, for example—so that each can best meet company objectives if its operations and planning are consistent with its nature. Starting with a rough definition of research as exploration of the unknown, Dr. Edward Seymour states the objective of his research department this way: "We aim to provide advanced technical capability in individual rocket powerplant problem areas prior to a commitment by the engineering organization to develop and deliver a new engine. By having research results available in usable form at the time a proposal is made, we can offer a more attractive solution to the customer's needs than that offered by our own competitors."

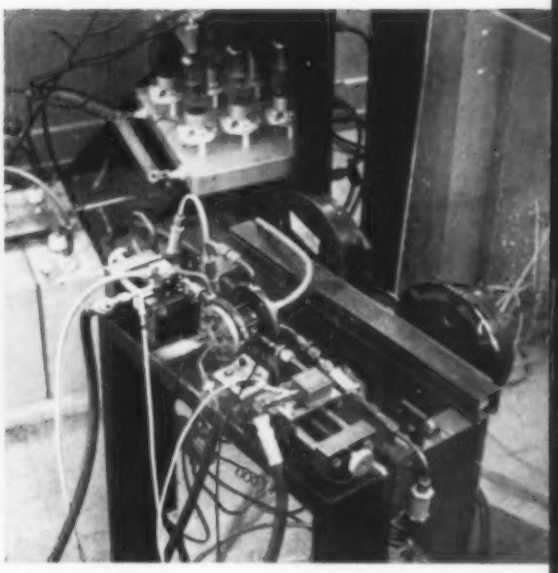
To stay a full time-cycle ahead of project development work, the amount of research called for by active projects is held to an absolute minimum. The only exceptions are where an unforeseen technical problem of some magnitude is encountered as the project unfolds. The research department then conducts the work with close attention to project need. "This way," says Seymour, "Engineering can concentrate on the shaping and integrating of component techniques into a successful powerplant, and Research can be free to explore technical problems whose solution will help design propulsion units that are one to five years away."

This approach requires a careful definition of research. Reaction Motors recognizes three levels, two in the "ap-



Today . . .

the "count-down" is a household word—and advanced powerplants, like the 50,000-lb thrust X-15 engine blasting off here, are being readied to take man into space. Test stand shown here was designed by Reaction Motors to simulate any altitude likely to be encountered by the X-15. First fully powered trials of the new test vehicle are due in mid-1959.



Tomorrow . . .

rocket control, and possibly even rocket propulsion, may depend on present research in magnetic field theory. Here, a tiny 2-oz-thrust research engine probes ion concentrations in high-impulse propellant reactions and how magnetic fields affect them.

plied" category; the other, basic research. In the first applied group are problems encountered on past and present development—nozzle materials, for example—the solution of which will enable the company to compete successfully on future contracts. The second applied category covers studies related to rocket propulsion, but where the impetus comes from the outside organizations. Here, Reaction's current research on the influence of ions on rocket combustion, sponsored by the Air Force Office of Scientific Research, is a good example. Basic research, the third group, is defined by Seymour this way: "The search for new knowledge where the sole motivation is the desire for greater understanding of scientific and engineering phenomena. An example here would be our current efforts to understand what makes certain propellant chemicals unstable, particularly at the higher temperatures."

Research costs money, and it's one thing to organize Research separately from Engineering and another to finance it that way in a company selling more brainpower than hardware. In this situation, there are three basic sources of capital: direct research contracts unconnected in any way with hardware development; supporting research assignments peeled off from existing development contracts; and company funds. This last source breaks down into two categories: funds for research aimed at establishing technical capabilities for the next cycle of development, and overhead funding for pioneering research.

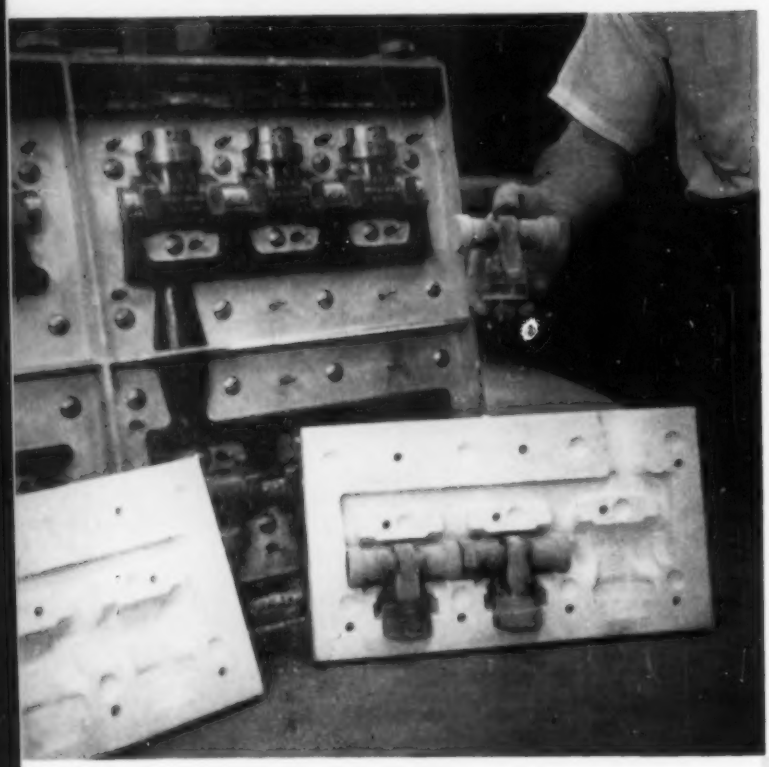
In pushing annual sales from $5 million to $30 million since 1952, heavy reliance has been placed on mobility of technical personnel and the creation of planning staffs on both engineering and research departments. Says Seymour: "Probably as many contracts come about through our own men spotting a problem that fits our R & D capabilities as come down the pipeline from prime contractors or the armed services." Engineering has a Technical Planning group whose personnel range from the weapons contractor all the way to the services where the original weapon mission is conceived. By presenting paper studies on recent new techniques to their opposite numbers, for example, these men help stimulate thinking that often coalesces into new-development contracts. Research has a similar team called Marketing and Long-range Planning, with its ear to the research terrain. Taking preliminary results from some company-funded project, these men meet with outside funding agencies like ONR and WADC, elicit proposal requests for further research, prepare and present the proposal, and follow up during negotiation.

Once the contract has been landed, one of the more serious organizational problems is how to free the project managers from burdensome administrative detail so the more creative work can go forward and on schedule. Problems of planning facilities, procuring equipment and shifting manpower as the job progresses have killed the inventive fires in many a manager's breast. One solution being tried at Reaction Motors is to assign these functions to two operations groups, one for research and one for engineering. These groups also assist the two directors in monitoring progress of work against original estimates of cost and time. ■

PASSPORT TO TOMORROW . . .

R&D

Austenal Inc . . . newest division of Howe Sounds Corp . . . sells new ideas to capture new investment-casting business. This way, it has boosted its share of business in an industry currently struggling with limited markets and surplus capacity.

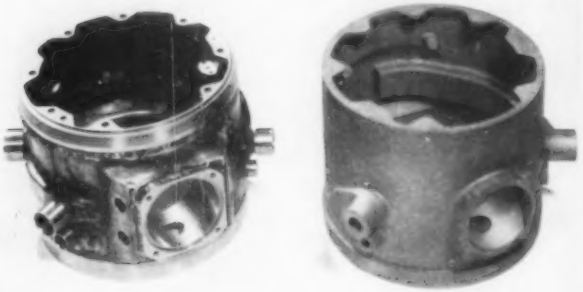


New casting process . . .

straddles the gap between shell molding and investment casting. Called an investment match-plate process by Austenal developers, the new technique yields parts close to investment-casting quality at costs approaching conventional shell-molding. Match plates are made from investment refractories without organic binder—so can be poured hot directly after firing. With inert molds, metals like low-carbon steels can be handled which tend to give trouble in conventional shell molding—where molds contain organic binders. Higher pouring temperatures permit thinner sections to be cast. Costs are below investment castings because expensive wax pattern is sidestepped and new molds are easier to make. Shown above are match plates for a gate valve body, cores, and original pattern.

Power-takeoff housing . . .

for jet engine is investment cast in one piece to replace complex weldment at left. Investment casting this part surmounted two basic casting problems: intricate coring and heavy bosses next to thin sections. These two parts weighed the same, but casting was 40% cheaper than weldment.



Turbine blade cluster . . .

red-hot from firing oven, is spotted in place for flip-flop pouring from indirect arc crucible. Investment mold is made by dipping a cluster of wax blade patterns into slurry of refractory powder, and sifting coarse powder over the wet cluster. Firing then sets the refractory mold and melts out the wax pattern. After casting, blades are cut from the headers, inspected by X-ray, Zyglo and ultrasonics and then polished.

is a product too!

When an industry has limited markets and excess capacity, competition can get pretty rough. That's why even a specialist in the precision investment-casting industry like Austenal Inc felt it had better do something two years ago to preserve its position.

That's why it centralized its R & D activities, sparking a two-pronged attack that has uncovered several innovations in precision-casting technique—and boosted business for Austenal's operating plants as well.

In centralizing, the first aim was for more sponsored development projects from outside firms. One good way to expand business is through contact with R & D personnel in customer companies. Explains Al Talbot, director of research: "One commodity the casting business has plenty of is 'trouble'—especially with performance requirements advancing so quickly. Yet casting is the most efficient method of distributing metal. By demonstrating ability to solve sticky casting problems, on an orderly business basis through sponsored projects, we establish an identity that extends our manufacturing plants and brings in business." A substantial part of Austenal's R & D effort goes to these sponsored projects.

A second area of concentrated R & D activity is new-process development, on which the company spends a major proportion of its research effort. Part of this goes to improving the basic investment-casting process, the rest into distinctly new techniques that will give most of the quality of investment casting—but at less cost. Talbot makes an interesting point here: "It's not well known outside the industry, but there are many different refinements within a given investment-casting system. We concentrate on lost-wax methods, but we have developed many sub-techniques from which we select one depending upon part shape, alloy specified and so on." To help develop these twists, Austenal's processing R & D section is backed up by chemical and anlytical groups that study the many materials involved: refractories, binders, waxes, plastics—and the alloys themselves, though the department does little alloy development of its own. These two groups also do much of the trouble-shooting research required by the operating plants, and help shake bugs out of new processes as they move into production.

Sponsored development is a bit unusual in the metals-fabrication industry. However, costs are high in the investment casting field and there are many variables—from shape to alloy specification. John Preston who directs this activity for Austenal, cites some reasons that make this approach highly desirable: "We find that when a customer sponsors a project he tends to define the problem more clearly, he follows the project more closely—and we establish excellent liaison with his research people."

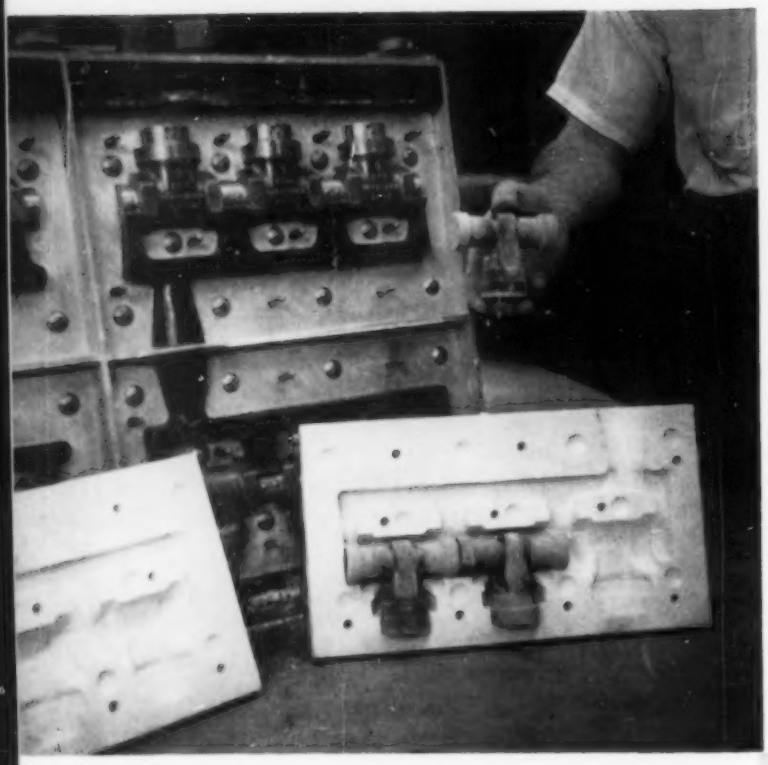
This dovetails nicely with Preston's philosophy of R & D: "I firmly believe that development under pressure gets best results. The engineer with a firm, agreed-upon deadline ahead of him gets to the heart of the problem quickly and shows less tendency to hedge his decisions." In practice, this means that Preston and his project engineer work out a schedule assigning target dates to each step—alloy study, selection of process, design of coring, design of cluster, invesement, pouring, test and so on. "Scheduling development jobs like this doesn't always work out," concedes Preston, "but this way the project engineer can handle several jobs at once, and the sponsor is happy because he knows the work is going ahead on a planned basis and his project is getting its fair share of attention."

New-process development—which research director Talbot terms "applied research"—doesn't lend itself too well to the schedule approach. Nonetheless, Stan Tingquist, process development manager, agrees that some pressure is valuable, even in research: "I do find that a little pressure makes the boys dig harder. My department carries a new process into pilot development, which usually means through the first commercial application. So we have some contact with customers—and their reaction, good or bad, to our efforts can be a real spur." When the process or technique works out well once on the customer level, it is transferred into the production plants and into Preston's repertory for application to sponsored projects.

One would expect to find a preponderance of metallurgists in Austenal's R & D, but this is not the case. The staff is an interesting blend of metallurgists, mechanical and chemical engineers, chemists and ceramic engineers. Says Preston, a metallurgist himself: "Often the non-metallurgist has a better feel for the practical aspects of casting problems—particularly where odd stress environments crop up, for example— than the average metallurgist like myself. The main prerequisite is curiosity and the ability to think logically regardless of the discipline involved. And most good engineers have these characteristics."

Stimulating and keeping track of ideas for development projects can be a tricky business—even in a small R & D setup like Austenal's. Then, too, there's only so much time and money available, so the proposed projects must be screened and priority established. To keep the system simple, research director Talbot merely requires that a brief memo be written setting out the season for the project, its scope, and the form of the end result—be it a data point, a set of curves, or a new prototype process. Called, "research investigation reports," these memos are logged for the patent record and screened by Talbot—usually in consultation with his section heads. Once the project is complete, a more lengthy report is written. These, along with monthly progress reports required of all project engineers, constitute tangible evidence of R & D progress for top management. "It takes more than paperwork, though," emphasizes Talbot. "The best evidence that our efforts here are paying off is orders coming in at the operating end." ■

R & D



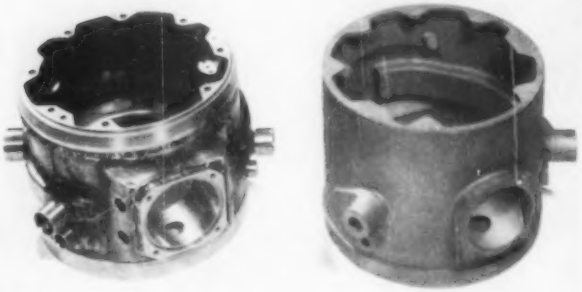
Austenal Inc . . . newest division of Howe Sounds Corp . . . sells new ideas to capture new investment-casting business. This way, it has boosted its share of business in an industry currently struggling with limited markets and surplus capacity.

New casting process . . .

straddles the gap between shell molding and investment casting. Called an investment match-plate process by Austenal developers, the new technique yields parts close to investment-casting quality at costs approaching conventional shell-molding. Match plates are made from investment refractories without organic binder—so can be poured hot directly after firing. With inert molds, metals like low-carbon steels can be handled which tend to give trouble in conventional shell molding—where molds contain organic binders. Higher pouring temperatures permit thinner sections to be cast. Costs are below investment castings because expensive wax pattern is sidestepped and new molds are easier to make. Shown above are match plates for a gate valve body, cores, and original pattern.

Power-takeoff housing . . .

for jet engine is investment cast in one piece to replace complex weldment at left. Investment casting this part surmounted two basic casting problems: intricate coring and heavy bosses next to thin sections. These two parts weighed the same, but casting was 40% cheaper than weldment.



Turbine blade cluster . . .

red-hot from firing oven, is spotted in place for flip-flop pouring from indirect arc crucible. Investment mold is made by dipping a cluster of wax blade patterns into slurry of refractory powder, and sifting coarse powder over the wet cluster. Firing then sets the refractory mold and melts out the wax pattern. After casting, blades are cut from the headers, inspected by X-ray, Zyglo and ultrasonics and then polished.

is a product too!

When an industry has limited markets and excess capacity, competition can get pretty rough. That's why even a specialist in the precision investment-casting industry like Austenal Inc felt it had better do something two years ago to preserve its position.

That's why it centralized its R & D activities, sparking a two-pronged attack that has uncovered several innovations in precision-casting technique—and boosted business for Austenal's operating plants as well.

In centralizing, the first aim was for more sponsored development projects from outside firms. One good way to expand business is through contact with R & D personnel in customer companies. Explains Al Talbot, director of research: "One commodity the casting business has plenty of is 'trouble'—especially with performance requirements advancing so quickly. Yet casting is the most efficient method of distributing metal. By demonstrating ability to solve sticky casting problems, on an orderly business basis through sponsored projects, we establish an identity that extends our manufacturing plants and brings in business." A substantial part of Austenal's R & D effort goes to these sponsored projects.

A second area of concentrated R & D activity is new-process development, on which the company spends a major proportion of its research effort. Part of this goes to improving the basic investment-casting process, the rest into distinctly new techniques that will give most of the quality of investment casting—but at less cost. Talbot makes an interesting point here: "It's not well known outside the industry, but there are many different refinements within a given investment-casting system. We concentrate on lost-wax methods, but we have developed many sub-techniques from which we select one depending upon part shape, alloy specified and so on." To help develop these twists, Austenal's processing R & D section is backed up by chemical and anlytical groups that study the many materials involved: refractories, binders, waxes, plastics—and the alloys themselves, though the department does little alloy development of its own. These two groups also do much of the trouble-shooting research required by the operating plants, and help shake bugs out of new processes as they move into production.

Sponsored development is a bit unusual in the metals-fabrication industry. However, costs are high in the investment casting field and there are many variables—from shape to alloy specification. John Preston who directs this activity for Austenal, cites some reasons that make this approach highly desirable: "We find that when a customer sponsors a project he tends to define the problem more clearly, he follows the project more closely—and we establish excellent liaison with his research people."

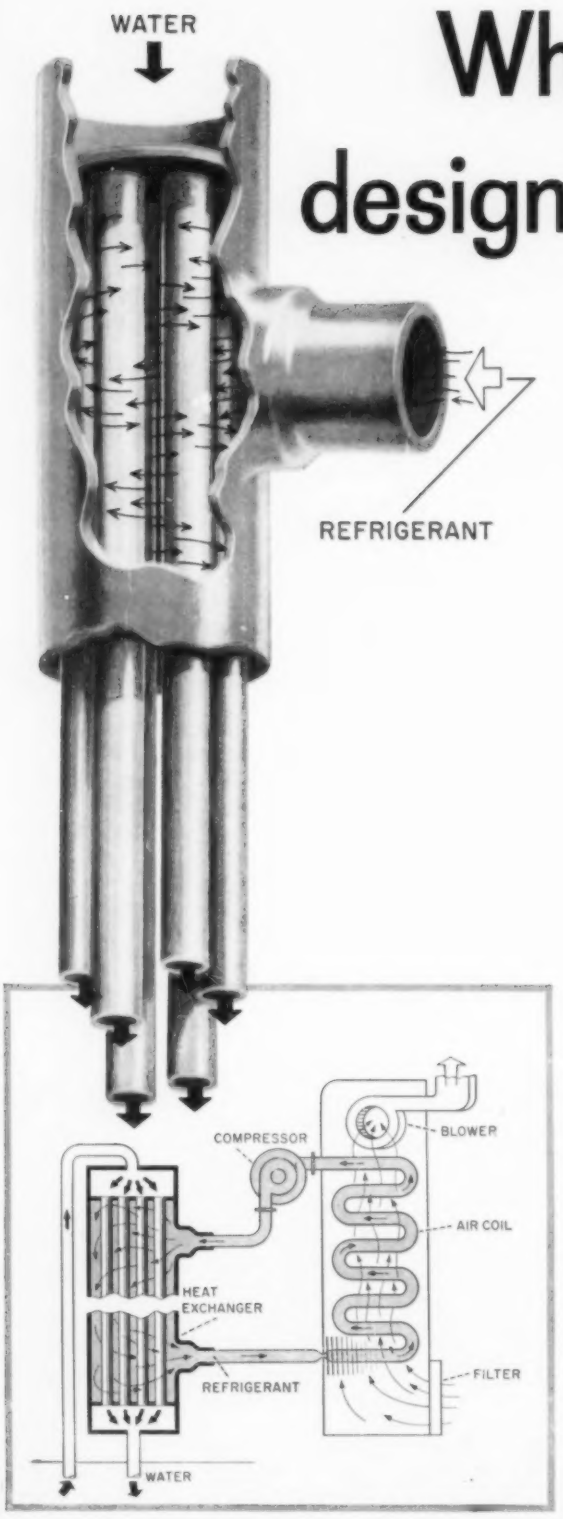
This dovetails nicely with Preston's philosophy of R & D: "I firmly believe that development under pressure gets best results. The engineer with a firm, agreed-upon deadline ahead of him gets to the heart of the problem quickly and shows less tendency to hedge his decisions." In practice, this means that Preston and his project engineer work out a schedule assigning target dates to each step—alloy study, selection of process, design of coring, design of cluster, invesement, pouring, test and so on. "Scheduling development jobs like this doesn't always work out," concedes Preston, "but this way the project engineer can handle several jobs at once, and the sponsor is happy because he knows the work is going ahead on a planned basis and his project is getting its fair share of attention."

New-process development—which research director Talbot terms "applied research"—doesn't lend itself too well to the schedule approach. Nonetheless, Stan Tingquist, process development manager, agrees that some pressure is valuable, even in research: "I do find that a little pressure makes the boys dig harder. My department carries a new process into pilot development, which usually means through the first commercial application. So we have some contact with customers—and their reaction, good or bad, to our efforts can be a real spur." When the process or technique works out well once on the customer level, it is transferred into the production plants and into Preston's repertory for application to sponsored projects.

One would expect to find a preponderance of metallurgists in Austenal's R & D, but this is not the case. The staff is an interesting blend of metallurgists, mechanical and chemical engineers, chemists and ceramic engineers. Says Preston, a metallurgist himself: "Often the non-metallurgist has a better feel for the practical aspects of casting problems—particularly where odd stress environments crop up, for example— than the average metallurgist like myself. The main prerequisite is curiosity and the ability to think logically regardless of the discipline involved. And most good engineers have these characteristics."

Stimulating and keeping track of ideas for development projects can be a tricky business—even in a small R & D setup like Austenal's. Then, too, there's only so much time and money available, so the proposed projects must be screened and priority established. To keep the system simple, research director Talbot merely requires that a brief memo be written setting out the season for the project, its scope, and the form of the end result—be it a data point, a set of curves, or a new prototype process. Called, "research investigation reports," these memos are logged for the patent record and screened by Talbot—usually in consultation with his section heads. Once the project is complete, a more lengthy report is written. These, along with monthly progress reports required of all project engineers, constitute tangible evidence of R & D progress for top management. "It takes more than paperwork, though," emphasizes Talbot. "The best evidence that our efforts here are paying off is orders coming in at the operating end." ■

What are today's design possibilities?



Design possibilities with the copper metals are as varied as these metals themselves. The forty-two industry standard alloys and the hundreds of special copper alloys offer combinations of electrical, thermal, chemical, structural, joining and finishing properties which are more valuable in this day of rigid performance specifications than ever before.

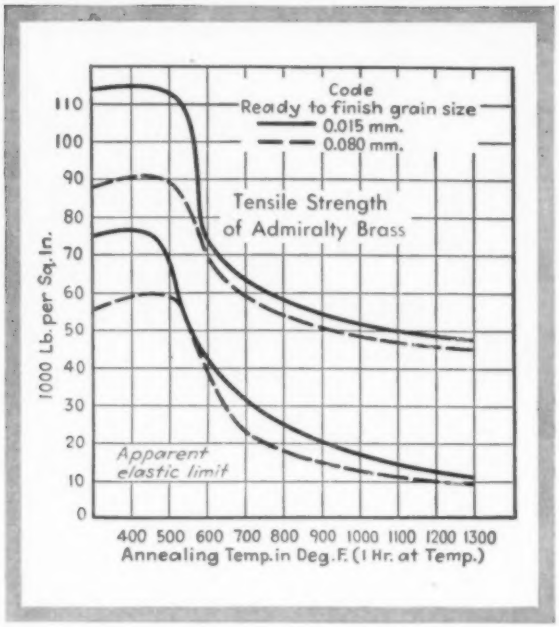
Today, most parts must meet several material requirements. Even a fastener, in addition to strength, may need corrosion resistant and high-finish properties. A supporting member may also have to conduct heat. Efficiency calls for materials versatility. And versatility calls for the copper metals. Although used since 7500 BC, copper is being re-examined as a new material with design possibilities that have scarcely been tapped. Here are some of the problems, and some of the properties that have special meaning at this time:

Design Problem — Heat pump condenser

The tube-in-tube condenser in a Typhoon Heat Pump must transfer heat between the ground water and the recirculating refrigerant. Corrosive sodium and sulphur compounds are dissolved in the ground water. The refrigerant, being highly volatile, must be confined in a leakproof system. The house air must be heated in winter and cooled in summer by passing over heat-transfer coils. The design requirements, then, include corrosion resistance, heat conductance and impermeability to the refrigerant. These requirements are met by three forms of copper. The ground water is contained in Admiralty Brass because of its excellent resistance to salt and sulphur corrosion. The refrigerant is contained in commercially-pure copper because of its density and the impermeability of its soldered joints. The air coil is a tinned copper fin soldered to a copper tube for maximum heat transfer at a realistic cost.

The good heat conductivity of copper and Admiralty Brass is, of course, important. But the conductivity of the metals themselves would be of little use if they did not also resist corrosion. The reason for this (besides durability) is because a heavy layer of corrosion products would severely reduce transfer efficiency.

TYPHOON HEAT PUMP CONDENSER SECTION (shown actual size). Heat exchange between ground water and refrigerant is accomplished in this unit. The corrosion resistance and high heat conductance of the copper metals used are vital to efficient operation. Drawing at bottom shows the complete cycles schematically.



← **EFFECT OF ANNEALING ON TENSILE STRENGTH** and apparent elastic limit of admiralty-metal strip, previously cold-rolled 6 B. & S Nos. (50% reduction of area) from two different grain sizes, 0.015 and 0.080 mm. (0.040-in. stock).

COPPER COILS being installed on the bottom of the main core vessel of the Organic Moderated Reactor Experiment.

As with any piping system, impact and tensile strengths of the groundwater tubing are also important. Slight shifts in the substrata can produce heavy stresses. Admiralty Brass, as manufactured for this tubing, develops a tensile strength of the order of 45,000 psi. Many copper alloys are even stronger. The high-zinc brasses, nickel silvers, beryllium copper, the silicon bronzes and the phosphor bronzes can be processed to provide tensile strengths of the order of 140,000 psi for hard-drawn wire. Strengths, of course, vary with temper. The graph above illustrates the range of strengths for Admiralty Brass.

Design Problem — Preheating for atomic reactor

The induction heating coils used in the Organic Moderated Reactor Experiment, a nuclear power project operated by Atomics International, a division of North American Aviation, Inc., for the Atomic Energy Commission, keep the organic moderating compound in a fluid state during reactor startup and shutdown. The necessary high temperatures are generated by eddy currents in the reactor tank. The design requirements for the coils were high electrical conductivity and good high-temperature characteristics. Oxygen-free, high-conductivity copper was the answer. Its freedom from impurities assures high conductivity and guards against high temperature oxidation and scaling.

Design Problem—Yours

The combination of properties that you need for today's multifunction design requirements can probably be found among the copper metals. The copper industry will help you find it. The Copper & Brass Research Association, 420 Lexington Ave., New York 17, N. Y., will welcome your inquiry.

FINISHING REQUIREMENTS. The nickel silvers and low-zinc brasses are widely used in ornamental applications because of their ease of plating and finishing as well as their cold-working properties. The new fine-grain brasses offer an ideal surface structure for economical high finish.

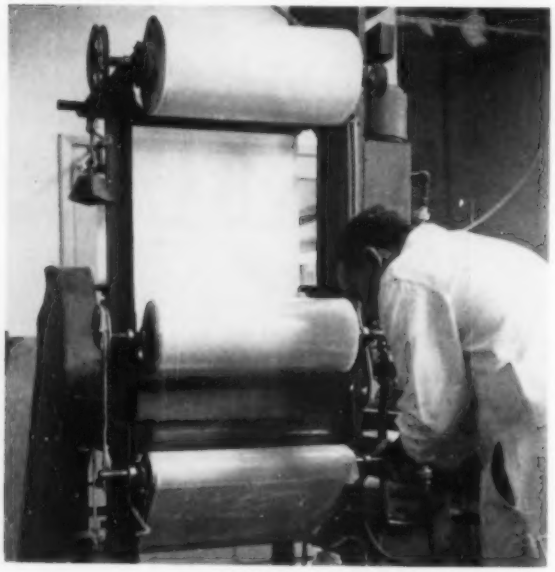
The picture above shows various combinations of coppers and brasses used decoratively in housewares.

THERE'S A NEW FRONTIER IN...

COPPER · BRASS · BRONZE

Sandwich adhesives . . .

for sandwich panels give high-temperature strength to aircraft structures. Here, technician peels away polyethylene sheeting from one side of recently developed epoxy film adhesive designed for 500 F. Glass cloth is carrier for tacky adhesive, and reinforces the joint too. Films like this are currently expensive, being used so far only with structures where temperature is the prime factor—like the phenolic-impregnated glass honeycomb core in foreground.



Leadweights and clothesline . . .

maintain roller tension on this lab rig for turning out experimental film-type adhesives. Upper roll is glass cloth, middle roll is polyethylene film—with second polyethylene roll on back side. Technician starts three layers onto winding roll after passing them through metering rolls (not shown). Partially cured adhesive is poured on glass cloth just ahead of nip-rolls, so that adhesive is forced into cloth and strippable protective facings are fixed in place.

NEED PRODUCT DIVERSIFICATION FAST?

Expand R & D and sell technical service to your customers. This is the approach that helped Rubber and Asbestos Corp add nearly 500 industrial adhesives to its product line in 10 years.

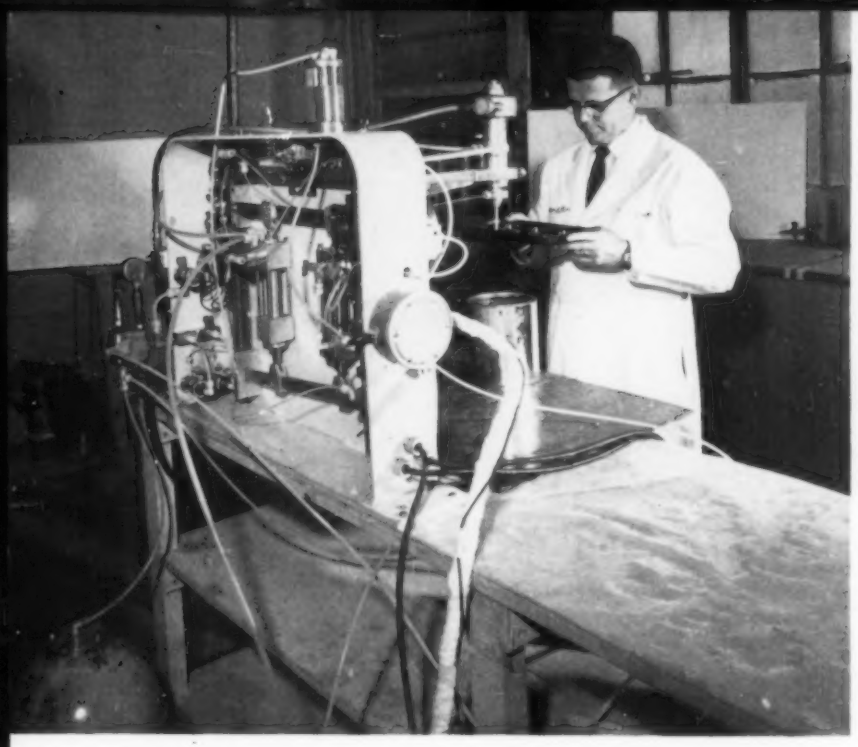
In the bustle of post-war 1945, Rubber and Asbestos Corp faced a problem. Wartime design has sparked much interest in adhesives as structural fasteners, but R&A's sales had been moping along at about the same level for the past eight years.

The solution, which multiplied sales 10-fold in as many years and promises to further quadruple them by 1965: Expand R & D activity and place it close to the customer for quick diversification of the product line. Devised by a young management team brought in 10 years ago, this close-hauled technical service program has pushed the company into every major type of industrial adhesive, and has added some 500 formulations to the roster—some of them "first" in the field.

Key to this kind of operation is a technically trained sales force with easy access to R & D, and backstopped by thorough market research. "We train our salesmen in the lab," says George Stanton, technical service manager, "and their problem reports from the field are actually formal requests for development work. These men are mostly adhesive chemists or chemical engineers, and know what facts the R & D men must have to get started. With these facts, plus the timing desired by the customer and an estimate of his probable consumption of the new adhesive, we set a research priority and go to work."

About 70% of R&A's new formulations are devised from specific problems posed, through technical sales, by single companies. Another 20% are sparked by recognition of industry-wide bonding problems, usually by sales, lab or market research. A good example is the company's series of epoxy-based adhesives for aircraft honeycomb structures. Here, high tooling cost in some brazed structures created an industry-wide market for adhesives as an alternate fabrication method.

Future markets uncovered by market research or future



Adhesive dispenser . . .

banishes batch mixing for two-part epoxies, speeds assembly of high production items like the battery-case cover being filled here. Two proportioning cylinders, one for base resin and one for catalyst, are kept filled from pressure spheres at rear of new device. On foot-pedal demand signal from operator, lower lever swings up—driving resin and catalyst to the mixing head in proportion to the set position of the two cylinders on the lever. Solenoid valves, timed with pedal, permit intermittent flow control.

needs of a current market accounts for another 5% of R&A's new products. "Here's where the real risk comes in," declares Martin Grover, technical manager. "Just how far ahead of the pack should you go with R & D? For example, in making the next move from our 250-F series epoxies we jumped to the 500-F level, and R & D devised a modified-epoxy tape adhesive that's truly different. But aircraft honeycomb isn't being produced for this temperature quite yet. We think we've timed it about right, but if not—the competition cashes in on our research!" The other 5% of R&A's new adhesives are adaptations of existing ones for other industries.

R&D operating on a technical service basis has other headaches too. As Grover puts it: "In developing new materials adhesives in our case, to meet highly diversified customer needs, you must be prepared to engineer the means for applying your own product. For example, catalyst-cured epoxy adhesives have revolutionized structural bonding—but their potential has not been realized because their fast-curing characteristic necessitates batch-production methods. To lick this, we finally came up with a dispensing machine that accurately meters out the components at any desired rate. So to expand markets for our adhesives, we had to get into machine design."

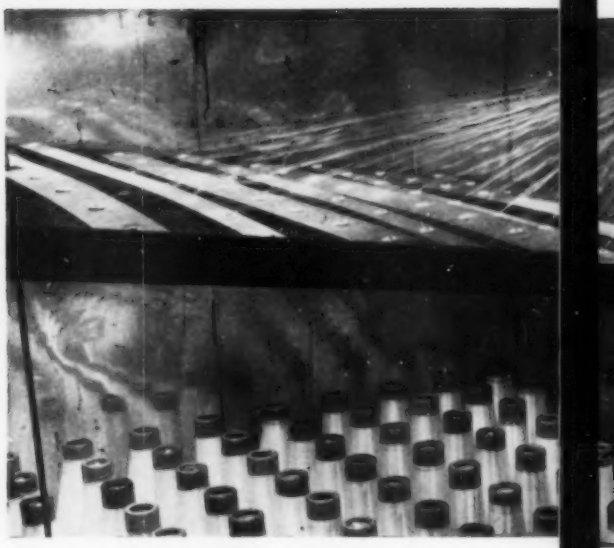
Exchange of technical information is not too difficult within a small company like R&A. Nonetheless, it's an important facet of any R & D activity. Grover finds that a monthly meeting of his technical personnel gives him the cross-fertilization of thought he seeks: "The whole staff, from managers to technicians, spends the day talking over new techniques that have been evolved since our last meeting, new ideas from the literature of surface chemistry, development obstacles that seem insoluble, and so on. Everyone is encouraged to speak up—even though his contribution may seem minor. The response to these sessions has been so enthusiastic that we've had to adjourn for supper occasionally and take up the cudgels in the evening."

Such discussions often uncover test methods for evaluating adhesives—tests which will be significant to the customer when he is shopping for the right formulation. This can be important where product development has the technical-service aspect, as it does at R&A. "By devising a test that is pertinent to the customer's operating conditions," explains Stanton, the technical service manager, "you stand a better chance of having your product accepted. There's another plus in this approach: a test which convinces one market on the virtues of an adhesive serves as a wedge for extending the product into other, possibly more lucrative, markets. A good example is an adhesive we developed to join Mylar polyester film to vinyl-coated cloth. A heat-aging test proved significant in the automotive environment involved, so we're looking for other areas where these materials are used under prolonged heating conditions."

Basic research activities can easily suffer from malnutrition in a highly sales-oriented R & D environment. To combat this, R&A has space set aside and time allotted for a certain amount of tinkering on longer range ideas. Concerning this kind of research, Grover sounds a warning: "Too often, when a company starts to do some 'basic' research, it expects all the results to be highly complex technical breakthroughs. Actually, research in the direction of simplifying existing products can be very rewarding as well. Here's an example: epoxy resins and the adhesives based on them started out to be sophisticated materials, expensive and hard to handle. We're finding out that you can simplify epoxies to go into adhesives that may compete with neoprene-base formulations—a workhorse series of industrial adhesives." ■

THREE STEPS TO NEW PRODUCTS AND SHORTER LEAD TIMES:

At Walter Kidde & Co . . . pneumatic-system specialists . . . A New Products Department spots unusual ideas, Research breadboards them, and Development designs the prototype . . . with Engineering qualifying components as design progresses.



Drawing glass threads together . . .

is first step to any plastic structure reinforced by winding. Here, threads are kept dry by heat lamps, collected and twisted as they pass opening at right. Twisted strands will then run through an epoxy-resin batch prior to winding on a mandrel.

From pneumatic pressure vessels to missile radomes seems a long step for any company, but the Walter Kidde Co has wrung just such virtuoso performance from its staff by an imaginative combination of exploiting intracompany talent and keeping a sharp weather eye on needs of the aircraft industry.

A common thread, literally, runs through Kidde pressure vessels and radomes. It's fiberglass yarn, plus considerable experience in textile-machinery design. Says Dan Mapes, soft-spoken general manager of Kidde's Engineering & Research Div, "When you know a lot about a technique—like handling yarn at high speeds, and you have a burning need for a product—like a lightweight pressure vessel for aircraft pneumatic-control systems, an R & D department that's wide awake should be able to meld the two into a potentially profitable product." This is just what happened. After much blood, sweat, and tears, Kidde engineers came up with its now-classic spherical pressure vessel —formed by winding filaments of resin-impregnated glass yarn around a rose-metal mandrel.

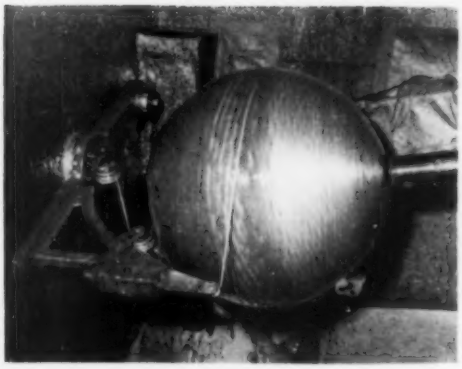
Extension of the principle to radomes came when a sharp-eyed Kidde research man visiting various aircraft manufacturers suggested the winding technique as a way out of troubles with current glass-reinforced plastic radomes. Actually an electronic window, a radome must be uniform in thickness and properties throughout—or the radar signal passing through is distorted. Developing a wound-fiber radome required the tangential thinking that best fits manager Mapes' favorite definition of research: "Doing what you have to do when you find you can no longer continue what you have been doing."

To exploit new-product ideas like this one, Kidde last year reorganized its Engineering and Research Division to include a new-products manager reporting directly to Mapes, who points out: "New products that are basically different or original come from, we find, R & D people—not salesmen or customers. So you've got to have a sympathetic ear for the man who wakes up one morning with the hot idea. This we have in our new-products manager, who eagerly scans the brief idea reports drawn up by idea-struck engineers. These reports state concept, plus the originator's views on possible markets for the product.

"New Products then explores market potential further, possibly talking with a few customers in the process. This has its limitations, though, especially where markets are not recognizable. Still, we don't bury an idea just because the market is hard to identify. We review it in each of the technical departments relating to it in any way—electronics, pneumatics, metallurgy and so on.

"Promising product ideas are then 'breadboarded'—that is, reduced to practice using components at hand. This is one function of our Research Dept. With a successful breadboard model and a promising market study, our Development Dept is ready to midwife a prototype—with the assistance of Engineering Operations, under whom are centered the model shop and prototype fabrication."

Much of Kidde's R & D is on a contract basis for the aviation industry where lead times are traditionally short. If the new product has been brought along on a speculative basis until a specific need can be generated, little time



Like a ball of string . . .

pressure vessel for aircraft pneumatic system is wound on a spherical mandrel. Arm carrying resin-soaked glass string rotates one way, mandrel the other way on its axis. For uniform properties in all directions, axis moves from horizontal to vertical and back several times during winding cycle. Mandrel is low-melting-point alloy, melts out during oven cure of the vessel.

Radomes . . .

are the latest twist in thread-wound structures. Here, a conical-shaped radome some 15 ft long is started on a specially constructed machine that follows mandrel profile as impregnated thread feeds over rollers. Paper protects machining head used for finish cut after mandrel, with its wound radome, return from curing oven nearby. Technique, which gives close control over wall thickness for optimum radar wave transmission, is also being studied for missile rocket casings and nonsymmetrical radomes for fighter planes.

problem exists. But in contract work, every organizational device is mustered to speed up prototype completion and start of manufacture. The talents of the chief test engineer provide one such device. Assigned to the Engineering Dept rather than R & D, his normal duties are to perform qualification tests on the final product for Kidde's customers. During a fast development project, however, he tests the various components of a prototype as it is being designed. Several alternate solenoid valves, for example, might be checked out here for reliability and capability. Testing all components concurrent with design of the prototype does more than save time, according to Mr. Mapes: "Cost of debugging is often 10 times the cost of getting the idea to the 'breadboard' stage—and this ratio is climbing steadily as environmental barriers stiffen and reliability margins are cut on newer products. For us, production numbers are low—300 items would be a large order. As an engineering job-shop, then, every completed product must work as specified—the first time. By testing as we develop, we get closer to this goal.

"There's a psychological plus, too, in this arrangement. We get around the common mental roadblocks to invention . . . the fellow who always says: 'It isn't practical—it hasn't been done that way—it won't work'. By getting the testing boys on the job early, we soon find out exactly what will and won't work, and why. If component testing determines existing parts won't do the job, then we know we have to design our own, or change our approach. Either way, hard fact makes the decision—not mental laziness or prejudice."

Translation of the prototype into a product that can be manufactured at reasonable cost is the responsibility of the Engineering Dept—with R & D sitting in whenever changes come up that might affect performance. Final design drawings must clear with R & D, however, to be sure original operating specifications are met. Sometimes, short lead times or new and complex products require that manufacturing be started using prototype drawings. Here, a qualified man from Manufacturing is assigned to the Development Dept early in the project, and works on the prototype along with the designers. "This way," says Mapes, "the first model arrives in Manufacturing with a production man in the van who knows the product in and out—and has anticipated the problems the shop will face. Time is saved, and that momentary inertia that grips any manufacturing organization when a new set of drawings drops on the desk is quickly overcome." Adds Mapes:

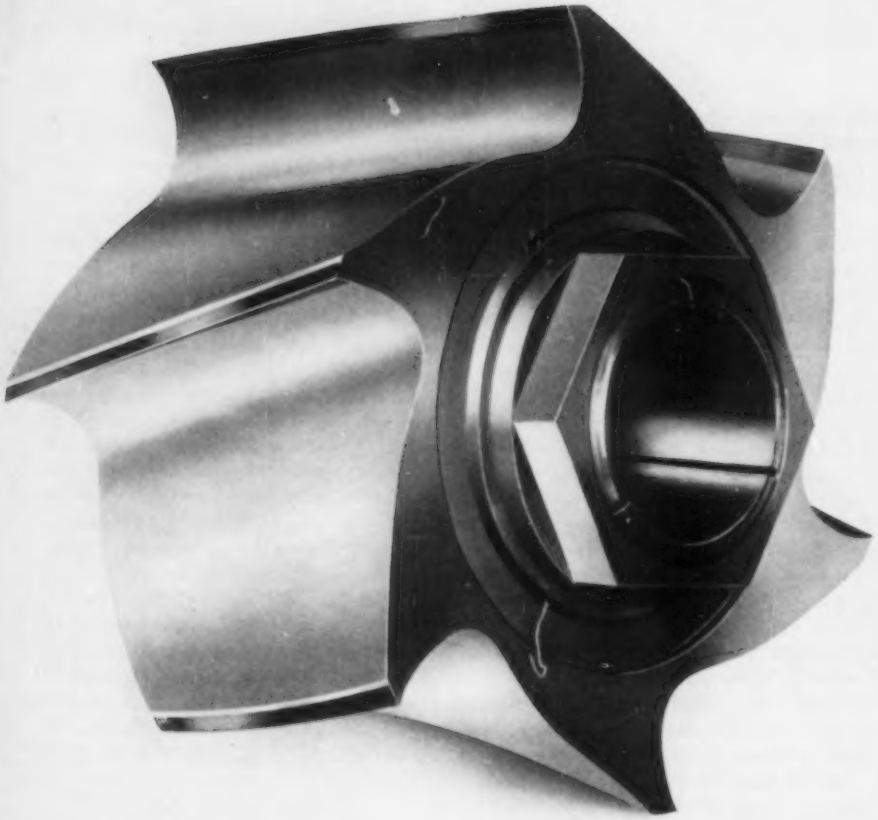
"All of this—research, development, prototype building, product engineering, manufacturing—takes more tenacity and drive than it does brilliant ideas—which are, after all, just an invitation to spend money. And toughness of mind, the ability to sell his idea to management—these are weak points in the creative engineer's arsenal these days. Improve our education system? First we've got to sell kids on the advantages of a thorough education. Why can't Madison Avenue sell education as well as it sells toothpaste and cars?"

Good question!

■

NOW: Higher strength costs you less! Specify TENZALOY*, the self-aging aluminum alloy that needs no heat treatment! TENZALOY is a corrosion resistant aluminum alloy that ages at room temperatures, gives high strength properties superior to those normally obtained only by solution treating, quenching and artificial aging. And these properties are stable, proved by conclusive test data taken over a ten year period. No special foundry techniques are required. No fluxes. Castability is excellent with sand cast and plaster molds, and many permanent molds. TENZALOY will not "grow". It takes a brilliant polish and anodizes clear white. Write for TENZALOY Bulletin No. 103 or call one of Federated's 22 sales offices. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

FEDERATED METALS DIVISION OF



ASARCO

AMERICAN SMELTING AND REFINING COMPANY

**TENZALOY is one of a complete range of Federated aluminum casting alloys. These and hundreds of other quality controlled non-ferrous metal products are produced in the 11 plants of the Federated Metals Division.*

Need Equipment for Rapid Reproduction of Braille

NEW YORK—Wanted . . . a device working on the punched tape principle, for reproducing Braille. This would result, of course, in a faster method of furnishing blind people with textbooks and literature, the demand for which cannot now be met by existing facilities. With all the techniques available today for rapid reproduction of printed matter, making one or two copies of a page of Braille still requires manual "retyping."

The US has 100 national agencies for the blind that would like to hear from anyone interested in designing such automatic equipment, or who has an idea how it might be designed. One man, Edward Flamm, of New York, who originated this idea, and has worked with various of the agencies, will coordinate the efforts. This, essentially, is what is needed:

1. A device for transferring Braille to tape. This will be a sensing mechanism to read Braille from left to right. It will be necessary to read a block matrix, translate the relative unique position of the raised pips into a predetermined code, and punch this code onto moving tape.
2. Converting tape to braille.

The Braille print head will have 63 characters, the same number of combinations that are designed for the punched tape. The material on which the Braille is written should be a light cardboard of high flexibility.

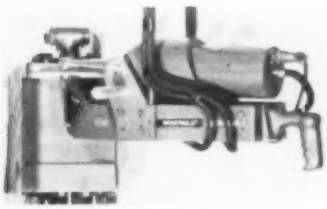
The print-out hard copy will be prepared in two forms for two different types of machines:

1) Continuous roll with horizontal performations after a predetermined number of lines of writing. This would be used for typewriter-like print-out, for light duty. The equipment should have a functional approach like the Friden writer.

2) Continuous fan-fold similar to IBM, with sprocket-controlled sides, of the same weight as (1). This will be used for heavy duty print-out similar to the IBM 400 series.

Both pieces of equipment would require added print-impact strength due to Braille impressions. Such equipment would have a world-wide market. Already there are 5000 people in the US who do Braille "typing." The number of users of this equipment elsewhere in the world are legion.

Titan launcher . . .
Developed by American Machine & Foundry Co, this underground launching system will serve the Air Force intercontinental ballistic missile, Titan. Eliminating conventional above-ground gantry system, AMF approach consists of an underground silo with interconnected service area containing remote-controlled electronic checkout equipment. Design being installed at Vandenberg AFB near Lompoc, Calif.



Ultrasonic welder . . .
A 2000-watt ultrasonic welder with 4-kva output has been designed by Aeroprojects, Inc to simplify assembling aluminum truck bodies. Aeroprojects officials say their device will weld aluminum of thicknesses that normally require a spot-welder of 150 kva capacity. However, joining carbon steel is still a job best accomplished by resistance spotwelding. Advantages of ultrasonics lower power consumption and line losses, less surface preparation.

Red Engineer Education Keyed to Soviet Needs

URBANA, ILL.—Engineering education in the USSR is high quality and scrupulously tailored to the needs of a planned economy. This observation was made by an eight-man mission of US engineering educators just returned from a three-week study of Soviet education under sponsorship of American Society for Engineering Education and National Science Foundation.

Present Soviet plans, the mission reported, call for 350,000 professional graduates—engineering, science, medicine, languages, etc.—each year for the next seven. Projected engineering grads have been boosted 90% over goals for the past seven years. These targets are based on requirements for expanded industrial capacity, need for replacements, and substitution of professionals for non-professionals.

Such planning demands that each student choose a narrow specialty when he enters college, and commit himself to a particular industrial job afterward. As a result engineering is divided into 160 specialties as mechanical engineer—automobile designer, mechanical engineer — automobile maintenance etc. This contrasts with 20 engineering fields accredited in US.

The mission concluded that Soviet engineers are well educated and as good as any elsewhere in the world. However, they believed that the Soviet engineer's outlook was limited because he knew little engineering outside his specialty.

Slate '60 Automatic Control Confab in Moscow

NEW YORK—The first congress of the International Federation of Automatic Control—its US representation to be supervised by the American Automatic Control Council—is scheduled for 1960 in Moscow. USSR's ambitious agenda will cover theory, components and measurements, and applications.

French Science Students Strike for More Space

PARIS—Fed up with attending classes in lecture halls jammed like the subway at rush hour, 19,000 students in the Faculty of Science at U. of Paris recently staged a 36-hour strike.

Professors joined students in an orderly demonstration in the courtyard at the Sorbonne. The strikers' demands: use of unoccupied lecture halls in other sections of the university; more instructors; and action on the building slated to go up on stilts at the Halle aux Vins, where work has been stalled by the delaying tactics of the powerful wine merchants association. *(PE—Apr. 21, p 27)*

Background of the strike is an incredible overloading of classroom and lab facilities (right) that virtually paralyzed the Faculty of Science. In some cases lecture halls were so packed that professors, unable to make their way to the lecture stand, cancelled classes. In the laboratories the jam was worse. In the general physics laboratory, sessions were scheduled from 7:30 am until 9 pm. Coupled with lack of space was a shortage of instructors—one for every 53 students.

Overloading was brought on by a 20% increase in student population as well as a radical revision in the program of studies for a degree comparable to a master's degree in sciences in the US. The new program reduces required length of study time from three years to two; purpose was to increase the output of scientifically trained personnel. However, it considerably increases the number of classroom hours per student. The French Ministry of Education put the new program into effect just before the fall session opened. Caught off balance, the Faculty lacked space or instructors to handle the added load.

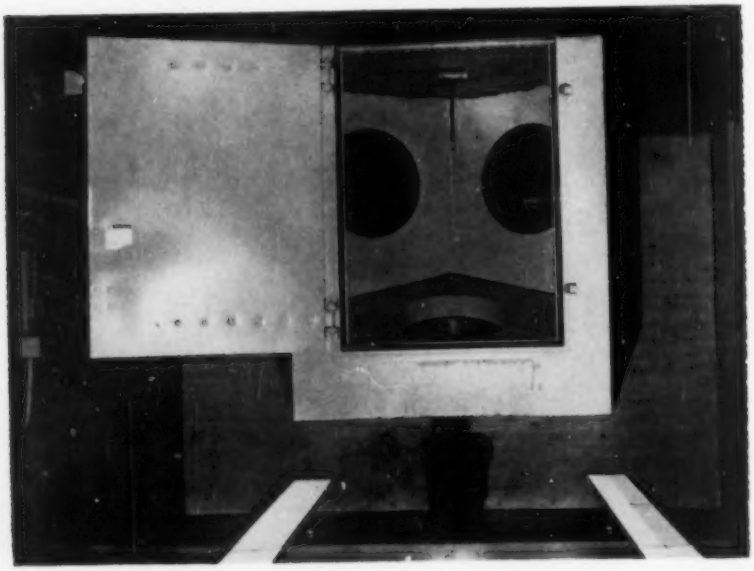
The strike succeeded to the extent that several amphitheatres were given over to the Faculty of Sciences—enough to handle some 3000 students. But the major problem, getting more laboratory space and assistance to direct laboratory work, is unsolved.

French revolution . . .
of graduate science students in Paris was brought on by crowded classroom conditions like this.

Electric Buses, Trucks, Driven by High Frequency Field

BONN, GERMANY—According to reports here, the Soviets have developed an electrical propulsion system without trolley wire for buses and trucks in city traffic. The Russian magazine Shilithshon Communalnoje Chsjaistwo says that power transmission from high frequency fields to the vehicles takes place without contact.

An overhead or underground cable serves as the transmitter to a pickup coil installed in the vehicle. The vehicle also has battery power.



Another 150-db noise chamber . . .
this one a 7-sided model for General Electric's Missile and Space Vehicle Dept, has no two sides parallel and has an inner volume of 120 cu ft. The chamber is inside a larger room with a volume of about 3150 cu ft and with ordinary, parallel-wall construction sound levels up to 150 db are produced in the small chamber. With the door to the smaller chamber open, as shown above, the large room acts as a reverberant chamber for testing large structures that would not fit in the small chamber. In this case sound levels in the bigger room can reach 140 db. Three horn-type loud- The facility was designed by GE's General Engineering lab in Schenectady. (See PE, Dec. 22, p. 58, "How to Make Sound Tests at 150 db.")

A push-button iron . . .
developed in West Germany is equipped with six colored pushbuttons for regulating temperature covering nylon, silk, wool, cotton and linen. An illuminated temperature inspection hole is provided in front of the color pushbutton system for controlling the temperature. Correct temperature is reached when color of the temperature inspection hole corresponds to color of the selected button. Heat of the iron is thus controlled by color comparison. When "nylon" button is pressed a 175 F temperature is maintained.

DEVELOPMENTS TO WATCH...

In V-belts, Dacron will be the standard reinforcement . . .

. . . Dayton Rubber Co predicts. Several manufacturers have already converted (Dayton included), and others are getting ready to make the change in the near future.

Advantages of the Dacron (polyester fiber) reinforcement as compared with rayon: increased service life (often 100%), higher strength (as much as 30%), increased heat resistance.

As Dayton points out, the increase in strength makes it possible to meet higher specifications with the same size belt, or to effect significant decreases in belt size.

New flexible sheeting for electrical use . . .

. . . has been developed by Anaconda Co and its subsidiary, Cochran Foil; and is now ready for design evaluation.

Made by laminating electro-deposited copper foil to kraft paper, and then creping the laminate, the new material provides an unusual combination of rigidity in one direction plus flexibility in another. It may well have application in transformer shielding and wrapped insulation.

(Note: For information on this material, address Room 2148, (Anaconda) 25 Broadway, New York 4; and for a roundup of other new developments in paper for engineering use, see forthcoming design issue.)

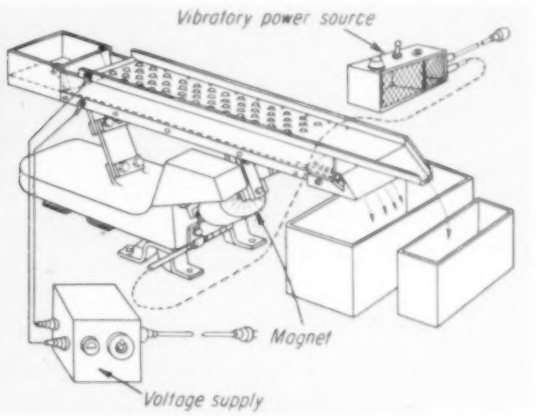
Electrostatic segregation . . .

. . . is ready to go to work as a means for separating materials that differ only slightly in electrical charge, says engineers at General Mills. After more than a decade of development, they've perfected and patented a machine to do the job—and it could be the forerunner of a whole new family of equipment.

While their original aim was separation of flour milling stocks, GM engineers report the machine can isolate titanium minerals from sand, remove metallic aluminum from its oxide, and perform other industrial chores.

In operation, particle mixtures are fed onto a conducting deck maintained at ground potential. Above them is another conveyor—a metal channel or trough (see picture and diagram) held at a rather high dc potential.

As it moves along, each particle accepts a characteristic electrostatic charge; and, depending on its nature, bounces upward into the trough, bounces part way and falls back, or remains on the lower deck. Because voltage and polarity are adjustable, it's possible to "tune" the device to accept or reject almost any type of particle. Applications outside the milling field are now being investigated.



New particle separator's electrostatic field is supplied by variable-voltage unit. Magnet, connected to power source at upper right, causes trough and deck to vibrate, moving particles along as the separation takes place.

DEVELOPMENTS

TO WATCH...

Urethane synthetic rubber tires for industrial trucks . . .

. . . and other mobile equipment, are being produced by Goodyear's Research Div "in pilot plant quantities." Advantages, according to Goodyear, include abrasion resistance and high load-bearing ability as well as resistance to oil, water, and chemicals. The new tires are said to resist cutting and chipping, too. (For technical data on cast solid polyurethane rubbers see *PE*—Sep 16, '57, p 68).

Rubber-based adhesives can be made stronger

. . . and more heat-resistant says Schenectady Varnish Co, with a new phenolic resin it has developed.

Designed specifically for use with nitrile rubber, the resin is a companion to the company's recently announced SP-126 resin, for neoprene-base compositions. The new one, SP-12, can be used with both cold-setting and hot-setting adhesives for rubber, leather, and other relatively soft materials.

Radiation has the jump on ultrasonics . . .

. . . at least when it comes to promoting chemical reactions, researcher Alfred Weissler told American Chemical Society. He described a series of tests with high-frequency sound waves (400 kc, 67 w) giving yields "about one thousand times smaller" than those which are obtained with gamma rays.

The reason: apparently only a very small amount of the available energy goes for reaction–promoting cavitation; the rest is dissipated through viscous absorption and other nonactive processes.

Stop-light stopper is the latest traffic-control gadget . . .

. . . in Britain. It's a relay-operated device that delays changing of the lights until an oncoming auto gets across.

As explained by British Information Services, the device takes its cue from two contact channels embedded in the roadway. Though they're spaced just 5 in. apart, they permit the device to calculate the speed of the oncoming car, and hold the lights so it can get through. The lights themselves have a maximum and minimum duration beyond which they cannot be extended. But the gadget can take advantage of the leeway between the two.

Automatic Telephone & Electric Co produced it to meet British Ministry of Transport specifications.

Lower-cost extrusions . . .

. . . are promised by Aluminium Limited, result of a new process that turns out "close tolerance" ingots. First application will be to material for cable sheathing; where, AL metallurgists say, ingots are being cast to dimensional tolerances one-twentieth of the normal commercial specification, and bowing can be held to a tolerance as close as $\frac{1}{8}$ in. in 9 ft.

Investigations are now underway to see whether the same process can eliminate scalping in other ingot products, and to produce smaller-dia ingots for impact extrusions "at considerable savings over present costs for the heavy slugs required."

Heat-shaped sections can be made . . .

. . . without cracking or wrinkling by taking advantage of new creped paper-plastic film laminates, says Cincinnati Industries Inc. The company has developed a special series of paper-plastic materials, ranging in thickness from materials like that shown here to heavy board, in single and multiple plies. Possible applications: instrument cases other lightweight formed parts.

With moderate heat and air pressure, polystyrene-paper laminate can be formed as shown here. —ARG

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

One of the ways to judge a skilled craftsman is by the tools he uses. They're invariably the best he can find – chosen to lighten his work, sharpen his skills. And, if the craftsman is a draftsman, they are, more often than not, products of K&E.

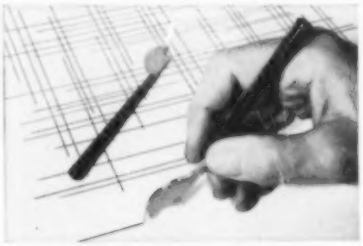
It may be that some of these products have escaped your attention (after all, we offer something over 8000 items). That's why we suggest you pay a visit to your K&E dealer whenever you can. It's a liberal education on what's new – as well as what's tried and true – in drafting equipment.

You'll find many products like these which can be highly useful in your work . . .

K&E "Quick Set" Bow Compass

The most remarkable feature of this compass is the speed and ease with which you can change settings–from diameters of 12 inches to 1/16 inch. With one hand, you can increase or decrease radii instantly and exactly. To go from small to larger radius, just press a spring release, and the legs will expand automatically. Stop approximately where you want, and make precise adjustments with a micrometer screw. To go from large to small, simply squeeze the legs of the compass together, then adjust precisely.

The K&E Quick Set combines the rigidity and precise adjustment of a standard bow compass, the simplicity and speed of a friction type compass, plus the finger tip control of K&E's unique design. You have to try the Quick Set to appreciate it fully. Two types are available. The N1071 fixed leg pencil compass, and the N1070 combination with interchangeable pen and pencil inserts. Both come with a box containing leads and spare needles. And with the N1070, a pen handle is provided for the pen insert which permits its use as a ruling pen. The compass can also be used as a divider by substituting one of the spare needle points for the lead in the pencil insert.

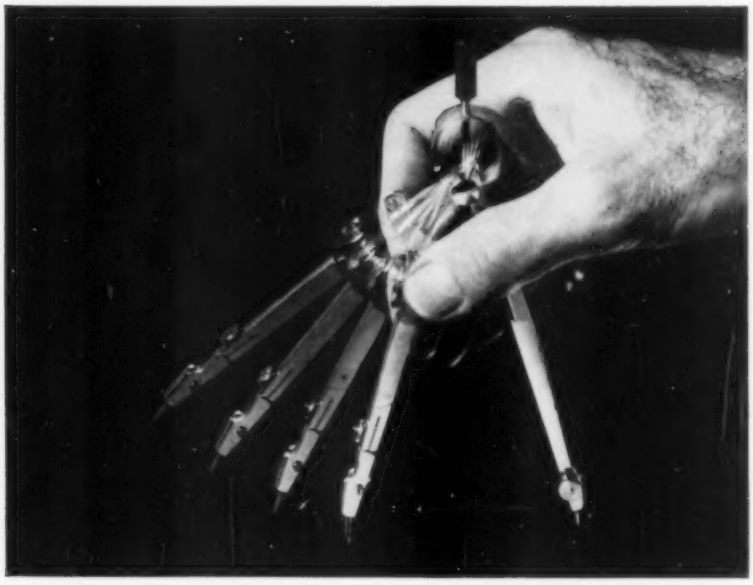


Marathon® Ruling Pens

K&E Marathon Long Line and Wide Line Ruling Pens (1092) hold an extra large ink supply – draw lines up to eight times longer than ordinary ruling pens. And because they are pre-set, line widths are always uniform, easy to match with complete accuracy. Ink flow is regular and even, lines are always sharp and clean edged.

An important feature of K&E Marathon Ruling Pens is that they will *not leak*. They can be laid on the work surface without risk of ink flowing out. That means you can fill several pens of different widths, use them as freely as you'd use pencils. They're easy to clean, too.

K&E Marathon Long Line Ruling Pens are available individually in line widths of .006, .009, .013, .020 inch – or in sets of three pens in line widths of .009, .013, .020 inch in a Leatherite case. Marathon *Wide Line* Ruling Pens come in line widths of .030 and .060 inch.



Leroy® Height and Slant Control Scriber

A versatile new Leroy scriber is now available which greatly expands the variety of lettering possible from a standard Leroy template.

Now, with the new Height and Slant Control Scriber (3237-12), you can form characters from vertical to slanting at any angle up to 45° forward. You can vary height from 60% to 150% of the size of letters on the template used. The width of letters remains the same.

Combinations of height and slant can be set quickly and easily. You just loosen the knob, move the scriber arm to the desired combination of height and slant, and tighten. That's all there is to it.

Stop in to see your nearest K&E dealer and ask to see these three products–small, perhaps, but mighty handy in the drafting room. Or drop us a line by mailing the coupon below . . .

KEUFFEL & ESSER CO., Dept. PE-12, Hoboken, N. J.

I'd like more information on:

- ☐ K&E Quick Set Compass
- ☐ Marathon Ruling Pens
- ☐ Leroy Height and Slant Control Scriber
- ☐ Please send me the name and address of my nearest K&E Dealer.

Name & Title _____

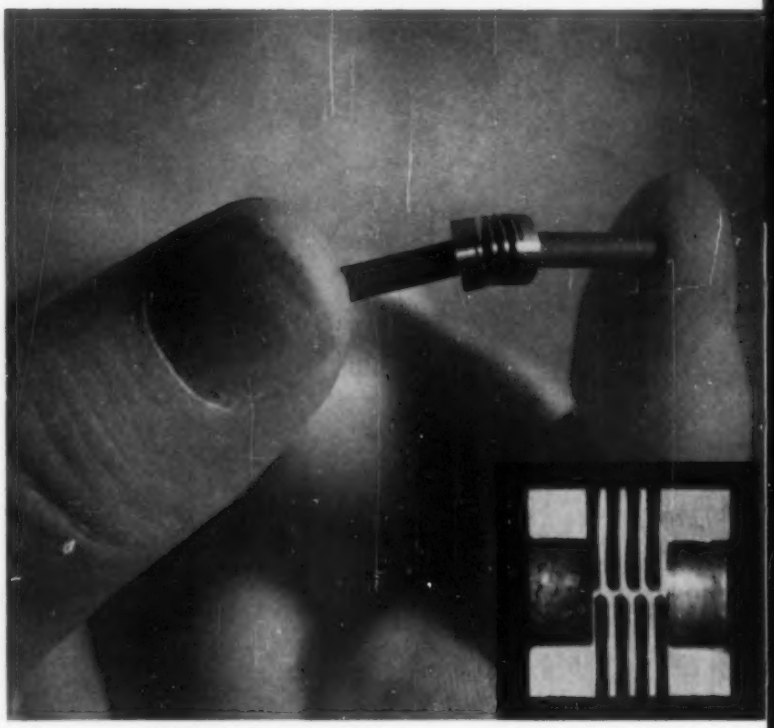
Company & Address _____

_____

SIGNIFICANT COMPONENTS

Remote-fill lubricators . . .
permit quick filling of lubricator bowls, even in hard-to-reach places, without interfering with production. Device uses button head fitting that can be installed on either side of lubricator body. Coupler mounts on end of rigid extension of oil delivery line. Two fittings are engaged by using lubricator body flange as a guide. Oil is forced from a portable hand pump through delivery line and into bowl. After filling, two fittings are uncoupled by upward movement of extension. Lubricators are priced from $9 to $21.50, depending upon size. Buttonhead attachments are 95¢ each. Pump and extension lines are additional. **Hannifin Co, Dept 126, Des Plaines, Ill.**

Circle 11, Reader Service Card



Miniature flexible coupling . . .
can be machined from stainless, aluminum, beryllium copper, high-temperature alloys by grinding a helical groove around OD (see cross-sectional view). Smooth bearing loads, constant velocity, zero backlash as well as ability to handle shaft misalignment are claimed by manufacturer. Integral flanges, gears, clutch and brake components can be incorporated. Illustrated is ⅛-in. ID coupling, available from stock. Torque capacity is said to exceed that of ¼-in. shaft. No apparent limit to coupling size, but tooling would have to be developed. **Helical Products Co, 1402 The Strand, Hermosa Beach, Calif.**

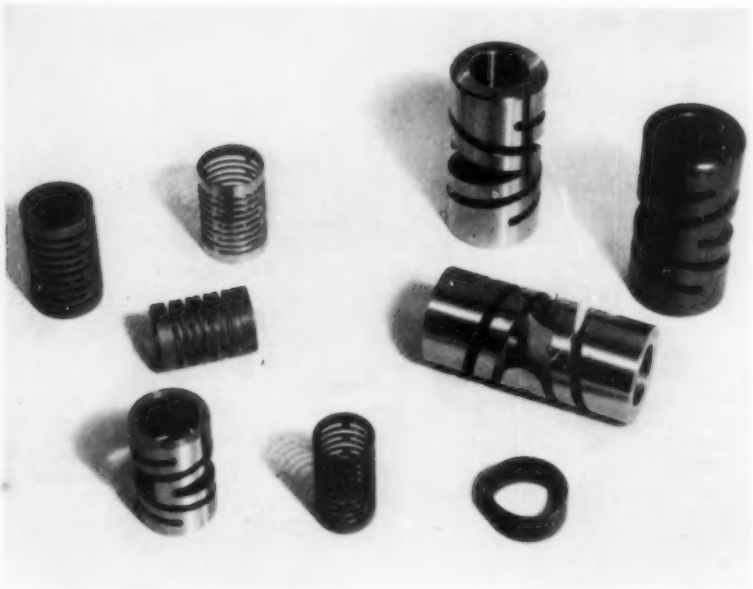
Circle 13, Reader Service Card

Heat-stable epoxy resin . . .
novolac that differs from conventional compounds in that it is based on epichlorohydrin and novolac rath than epichlorohydrin and Bisphenol-A. Said to exhibit greater strength and more chemical resistance than conventional resins. Also available in 85% solids solution to facilitate handling. Typical uses are in electrical printed circuits, high-strength adhesives for metals and glass reinforced laminates. Estimated to sell in same range as conventional solid and liquid epoxies marketed by Dow, which were recently reduced 10 to 20% in price. **Dow Chemical Co, Midland, Mich.**

Circle 12, Reader Service Card

Miniature stepping motor . . .
and switch that cannot double-index from shock, vibration or over-voltage is offered in two models. Both are available in uni-directional and bi-directional units. Bi-directional feature is achieved by using two identical stepping motors driving same shaft in opposite directions. Output shaft is rotated 36° for each input impulse, up to 40 steps per sec. Both units are available in standard voltages of 24, 48 and 90 c dc and 110 v ac. Dc models have max input power rating of 12 w; ac units are rated 15 w max. Models are 2.31 x 3.06-in. x 2.11 or 3.67 in. deep. Recommended for use in programming devices and for sequential operations where digital to analog information conversion must be made with precise control and max reliability. List prices for standard motors are $48 and $65; for standard units with 2, 4 and 5-deck switches, $64, $91 and 95, respectively. Discounts, according to quantity, range to 14% for 100 units. Prices FOB North Hollywood. About 3-wk delivery. **Data Instruments Div, Telecomputing Corp, 12838 Saticoy St, North Hollywood, Calif.**

Circle 14, Reader Service Card



Herringbone and gimbal compression springs . . .
are machined, heat treated and ground to provide square ends, tight control of free length, and exact matching of specified spring rate. Constructed to eliminate twist or turning moment between end faces that can cause shifting. Unlike coil designs, spring rate is said to be uniform from zero load up, since effective length of turn does not change with load. Symmetric application of force output at points diametrically opposite eliminates tendency to cock. Herringbone is more difficult to manufacture, but for equivalent characteristics it occupies less volume than gimbal construction. Capacity, 100 to 1000 psi and higher; min size, 1 x ¼ in. dia—no apparent max at present. 60-day delivery after approval of specs. **Consolidated Controls Corp, Bethel, Conn.**

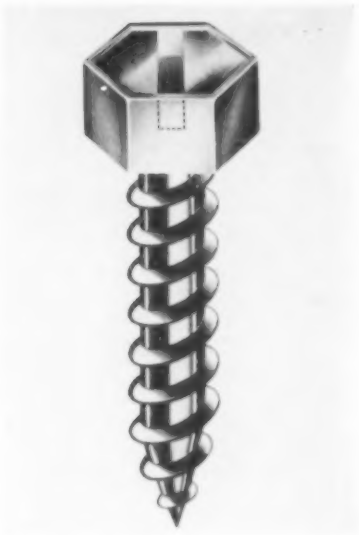
Circle 15, Reader Service Card

Subminiature thermal switch . . .
is a chemical-type, non-repetitive switch for direct operation of power devices, triggering one thermal reaction from another, operating as a time delay by use of thermal insulation or as a safety and warning device. Normally-open with a latching action, it maintains a closed circuit after switching, regardless of subsequent temperature changes. Small cartridge is ⅞ in. dia and is offered in six styles. 100 units of smallest style weigh less than 1 oz. Current rating is 5 amp, ac or dc, continuous. Max working voltage is 220 v. Available with switching temperatures of 150, 175, 200, 225, 250, 275, 300, 325 and 500 F. Accuracy is said to be 2%. Withstands extreme shock and vibration and temperatures down to −65 F. **MiniTec, 5423 Delaware Ave, Los Angeles 41.**

Circle 14, Reader Service Card

Alloy for 1800 to 2300 F . . .
is offered in static, centrifugal and shell molded castings to customer's designs. High nickel alloy is said to maintain high working strength at 2200 F for many applications and usable working strength for selected applications at 2300 F. Said to be extremely resistant to oxidation at these temperatures. slightly higher than conventional high nickel alloy castings. **Duraloy Co, Scottdale, Penna.**

Circle 17, Reader Service Card



Burr-free screw . . .
has indented hexhead, with slot formed within recesses of indentation at the same time that head is being formed. Screws are said to have sharper corners and to eliminate scrap loss, cut fingers and difficult assembly. Socket drivers hit screws because, with elimination of burrs, there is no variation in tolerances. **Universal Screw Co, 2401 Brummel Pl, Evanston, Ill.**

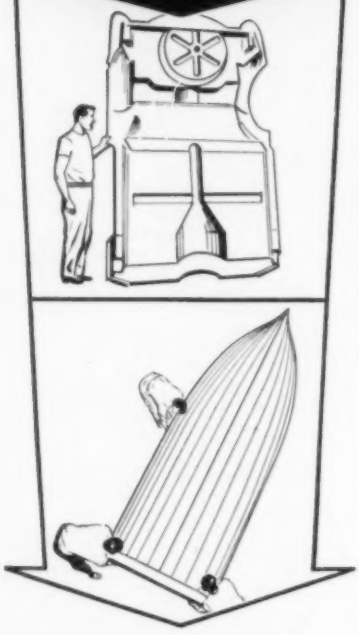
Circle 18, Reader Service Card

Composite metal . . .
is said to have all the superior qualities of conventional clad metal strip, yet priced substantially lower than clad metals. A hard, dense layer of metal is electrolytically deposited and heat-treated to achieve a metallurgical bond to a base metal, then rolled to finished thickness and temper. Surface layer is rolled to same temper, as base metal. Overlay metals include silver, nickel, copper, tin, zinc, gold cadmium. In widths from ⅛ to 7 in. for most combinations. Plating thickness ranges from 0.0001 in. min per side to 0.005 in. max per side. Over-all thickness ranges from 0.125 to 0.001 in. Can be supplied with overlay on one or both sides, either with equal thickness on each side or to specifications. Strip can be stamped drawn or formed as readily as any clad metal and can be soldered, brazed or welded. Available in commercial quantities. **American Silver Co, 36-07 Prince St, Flushing 54, NY.**

Circle 19, Reader Service Card

Large parts, too, can be mass-produced of strong, lightweight

MOLDED FIBER GLASS



No longer must you use the same old metals for your larger pieces. Now you can modernize your products and spruce up designs with tough, economical MOLDED FIBER GLASS.

Molded Fiber Glass Body Company can custom-mold your big products of strong, lightweight, rust-proof, impact-resistant MOLDED FIBER GLASS, using matched metal dies...

with savings of 50% in tooling time
and 80% in tooling costs!

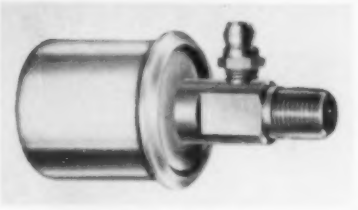
And...MOLDED FIBER GLASS parts can be molded into shapes impossible to make with metals... complex, one-piece, deep-draw parts ... pigmented in any color, or painted.

Molded Fiber Glass Body Company has been successfully mass-producing large parts for the transportation industry for over five years ... gaining experience and production know-how unexcelled **anywhere.**

What about switching to MOLDED FIBER GLASS for **your** large products? Write today for free literature and cost estimates.

Molded Fiber Glass Body Company
4623 Benefit Avenue, Ashtabula, Ohio

SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .



Automatic lubricator . . .

holds reservoir of lubricant and injects grease only as needed. Position of pressure cup on unit signals amount of grease remaining in reservoir. Lubricator, measuring 2¼ x 1⅛ in. dia, is installed one to each bearing by removing fitting and screwing automatic lubricator into place. Will operate in any position and can be mounted in cramped positions with standard adapter fittings. Lubricator is filled with any standard grease gun. Combination of bearing vacuum and spring pressure in lubricator discharges only enough grease to replace amount used in bearing. Lubricators sell at $18.25 per doz. **Anchor Chemical Co, 10723 Briggs Rd, Cleveland 11.**

Circle 20, Reader Service Card

Anticontaminant grease . . .

coats insulator surfaces, engulfing contaminants which, when moistened by dew or light rain, might lower dielectric characteristics. Grease, offered in paste and liquid form, has silicone base. Sheds water droplets and encapsulates contamination particles in moisture-proof seal. Can be reapplied without removing previous coatings. **Insulator Dept, General Electric Co, PO Box 57, Baltimore 3.**

Circle 21, Reader Service Card

Snap-lock socket . . .

for printed circuit boards makes possible testing of complete circuits prior to final soldering. Beryllium-copper spring band snap-locks wire after insertion during circuit board build-up. Sockets are finished in gold-flashed copper alloy. Designed to solve innumerable printed-circuit board problems involving plug-in components. Available for circuit boards measuring ⅛ to ⅛ in. thick. **Grinnell-Harris Electronics Inc, 4130 Temple City Blvd, Rosemead, Calif.**

Circle 22, Reader Service Card

Double-end shutoff fitting . . .

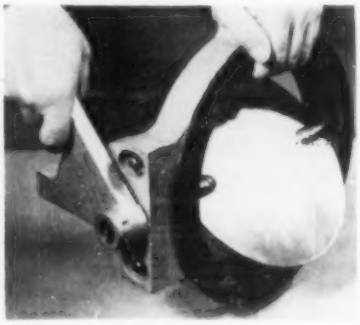
for use on pneumatic or hydraulic lines is offered in sizes for ¼ through ⅜ in. OD tube. Available in steel, stainless steel and brass, normally furnished with Buna-N O-rings. Fitting has seals in both parts of unit, preventing loss of pressure when disconnected. **Crawford Fitting Co, 884 E 140th St, Cleveland 10.**

Circle 23, Reader Service Card

Electronic time delays . . .

have operating ranges of from 60 millisec to 600 sec. Relays are said to include one of smallest units achieved to date for a 600-sec timer fitted with a 6PDT, 5-amp relay. Over-all size is 2 x 2 x 3 in. Total weight is 15 oz. Available with 1 to 6-pole load switches. Standard input is 28 v dc. Withstands severe shock and vibration and environmental temperatures from —89.6 to 257 F, performing to within 5% of specifications in that range. Life is said to be 100,000 operations min. Delivery to most specifications, within 6 to 8 wk. **Voi-Shan Electronics, 13259 Sherman Way, North Hollywood, Calif.**

Circle 24, Reader Service Card



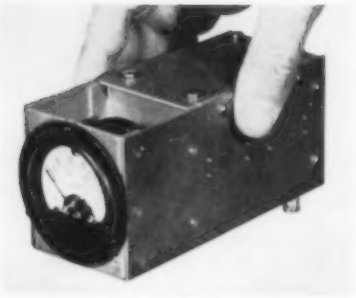
Dust-tight valve . . .

for controlling flow of dry powders and granulations. Valve body is covered with removable neoprene liner. Vane and O-ring sealed shafts are type 18-8 chromium-nickel stainless steel. All parts, including liner, can be replaced in field. Discharge handle is operated against a radial, positive-positioning plate that locks valve in position. Available in 8, 10 and 12 in. sizes with 8¼, 10¼ and 12¼ in. opening and 10½, 12½ and 14¾ in. OD. All valves are 1¼ in. thick. **Patterson-Kelley Co, Inc, Stroudsburg, Penna.**

Circle 25, Reader Service Card

Electronic voltmeter . . .

is said to be among smallest self-contained units offered, meeting MIL-T-945A. Operates on power of 400-cps, 115-v ac, single-phase. Occupies 2¾ x 2½-in. panel space and is less than 6 in. deep. Held in place with three meter screws, with only meter bezel in front of panel



and instrument case behind it. Available in any range from 0 to 30 milliv to 0 to 300 v. Sensitivity of units can be changed if external attenuator is used. Frequency response is 40 cps to 50 kc. Input impedance is 1 megohm, 15 $\mu\mu$f. Stability with 10% change in line voltage is said to be better than 2%; accuracy to be ±3%. **Metronix Inc, Chesterland, Ohio.**

Circle 26, Reader Service Card

Pressure relief valve . . .
for temperatures to 1800 F and pressures to 1000 psi, weighs 0.04 lb. For $\frac{3}{16}$-in. line size. Valve is suitable for pressure relief applications in gas generator combustion chambers, or elsewhere in auxiliary power or main propulsion systems. **Aero Supply Mfg Co, Corry, Penna.**

Circle 27, Reader Service Card

Measuring small distances . . .
with accuracy of 1% without physical contact is possible with an instrument with range of 0 to 45,000 microin. Particularly suited to measurements on rotating objects and for monitoring distance with reference to a predetermined value. Because no physical contact is necessary, determinations of temperature coefficient, moduli of elasticity, rigidity and bulk, Poisson's ratio and dilation are said to be possible on fragile samples. Measurement, by means of a transformer-coupled bridge in conjunction with noncontacting probe, is in terms of capacitance change between test surface and the probe, and is given directly from micrometer scale. Capacitance of probe cable can be counteracted, permitting remote measurements. Said to be unaffected by strong external magnetic fields. **Wayne Kerr Corp, PO Box 801, Philadelphia 5.**

Circle 28, Reader ServiceCard

mr

MANUFACTURING RESEARCH ENGINEERS

Outstanding career opportunities are available, now, at Boeing

These are long-range openings with plenty of opportunities for advancement. Boeing is the nation's leading manufacturer of advanced multi-jet aircraft and of long-range area defense guided missiles. Boeing is also at work on solid-propellant ballistic missiles, spacecraft and other future-growth projects.

These, and other projects, offer challenge and opportunity to experienced manufacturing research engineers, with a BS or advanced degrees in Engineering, Physics, Chemistry or Mathematics. Assignments include responsibility for initiating the planning and conducting of test programs in the development of improved manufacturing methods...and developing and integrating processes and manufacturing techniques into the production of advanced-design airframes, missiles and weapon systems. Openings are available in such areas as:

SEALING—Vessels and structures, both liquid and gas-tight.

METAL FINISHING—By plating or organic conversion coatings.

PLASTICS—Techniques involving both structural and decorative uses.

METAL BONDING—With structural adhesives.

WELDING—Fusion and resistance welding of exotic materials by means of advanced new techniques.

METAL REMOVAL—Advanced techniques for exotic materials.

METAL BEHAVIOR—Basic analytical studies during processing.

BRAZING—Stainless steel honeycomb structure in controlled atmosphere at high temperature.

FORMING—Elevated temperature formability of metals analysis.

HEAT TREAT—Applied studies of thermodynamics in connection with metals heat treating.

ELECTRICAL SYSTEMS AND FUNCTIONAL TEST—Fabrication, installation and functional test of electric and electronic systems.

OPTICS—Application of optical instruments to tooling and functional test problems.

At Boeing you'll enjoy many advantages, including the use of the most extensive array of research and development laboratories and facilities in industry. You'll be working with leaders in your field, in an environment conducive to advancement and rewarding achievement.

Drop a note outlining educational and experience background to:

Mr. Stanley M. Little
Dept. PP-1
P. O. Box 3822
Boeing Airplane Company
Seattle 24, Washington

BOEING

MICROBEADS

. . . they roll like mad!

Because they *are* perfect spheres, these microscopic glass beads do just that . . . they roll like mad. This characteristic presents vast possibilities for their use as a dry lubricant.

Microbeads possess quite a number of very interesting physical and chemical properties. Here may be the material you've been searching for . . . to solve your particular problem. You'll never know until you've held them in your hand . . . seen them with your own eyes . . . worked with them. For free samples and technical data, write:

M1-A

MICROBEADS, Inc.
P.O. Box 241/Jackson, Miss.

Microscopic Glass Beads for Industrial and Reflective Purposes

CIRCLE 57 READER SERVICE CARD

EMPLOYMENT OPPORTUNITIES

DISPLAYED RATE

The advertising rate is $31.20 per inch for all advertising appearing on other than contract basis. Frequency rates quoted on request.

UNDISPLAYED RATE

$2.10 per line, minimum 3 lines. Position Wanted ads in this style ½ the above rate. To figure advanced payment count 5 average words to a line.

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. BOX 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

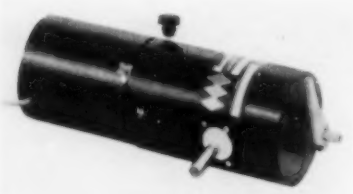
POSITION WANTED

Production Manager—12 years background in mechanization and mass production of metal parts & precision assemblies. Will design, develop products and efficient production methods. Supervise tool shop as well as production line. Set up quality control. Resourcefull & Creative. Age 38. U. S. Citizen. PW-9550, Product Engineering.

When Answering
BOX NUMBERS

to expedite the handling of your correspondence and avoid confusion, please do not address a single reply to more than one individual box number. Be sure to address separate replies for each advertisement.

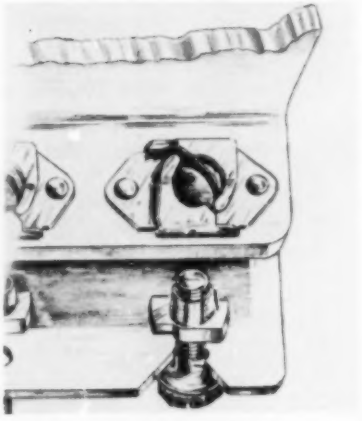
SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .



Miniature mechanical drive . . .

weighing 1¾ lb is said to offer frequency response equivalent to hydraulic system and triple that of electrical system. Drive without motor is 3¾ in. x 2 in. dia. Force of 2 in.-oz max on control shaft changes speed from full forward to full reverse in 0.05 sec. Output torque is constant and efficiency said to be between 85 and 95%. Available with several modifications. Applications include actuators, computers, integrators and instrumentation. **Humphrey Products Div, 3794 Rosecrans St, San Diego 10, Calif.**

Circle 29, Reader Service Card



Quick-release panel nut . . .

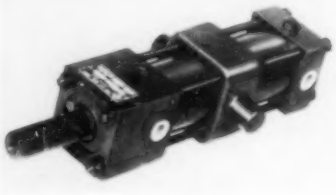
composed of a nut and basket retainer can be installed without special tools, and has no springs or pins to break or distort. As bolt is rotated, self-locking nut turns from entry slot of basket and lifts on beveled edge of nut lugs into basket recess. Lifting action of nut draws up screw and attached cover plate into positive contact with base plate at desired preset loading. A ¼-turn of the bolt is sufficient to complete lock-unlock action. Threaded fastener permits infinite grip adjustment for full length of the bolt. Presently available in ¼-20 thread size; ¼-28 thread will soon be available. Fasteners list for 17.2¢ each, less graduated quantity discount to 50% max for 100M lots. **Elastic Stop Nut Corp of America, 2330 Vauxhall Rd, Union, NJ.**

Circle 30, Reader Service Card

Single-sheet reproduction . . .

of every kind of original matter, including all colors, with photographic quality and exactness is offered in a new photocopy process. Chemical-stabilized silver photography process uses a single sheet of sensitized paper to make a copy. By exposing the original in contact with this sensitized sheet, a right-reading negative stat is obtained by a single pass through the machine in less than 30 sec. This stat can serve as finished copy, or be used as master copy to make one or more positive copies by repeating procedure. Positive copies can be made from one permanent negative at a cost of about 4¢ per copy. Printing rate is about 4 positives per min. Negative can be filed and reused later at any time to make additional positives when needed. Automatic printer and processor combines in a single desktop-size machine. Capable of copying material up to 9 in. wide and of any length. Exposure in process can be either reflex or print-through. Solutions are automatically into processor by inserting necks into sockets. Prints leave the processor damp, not tacky. **Peerless Photo Products Inc, Shoreham, NY.**

Circle 31, Reader Service Card



Heavy-duty cylinders . . .

for air service to 200 psi and hydraulic service to 1000 psi have adjustable trunnion mounts. Solid, one-piece trunnion is supported and positioned by four threaded cylinder tie-rods. Design is said to permit use of a full diameter, full strength cylinder tube and does not employ weakening cuts or grooves in the tube. Built to JIC standards. Nine available bore sizes range from 1½ to 8 in. with strokes to specifications. Models are offered noncushioned, cushioned blind end, cushioned rod end or cushioned both ends in five mounting styles. Seals are for operation at temperatures from —20 to 150 F. **SP Mfg Corp, 30201 Aurora Rd, Solon, Ohio.**

Circle 32, Reader Service Card

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Allied Research Products, Inc. ..... 2nd Cover
Aluminum Co. of America .. 3rd Cover
American Cyanamid Co., Plastics & Resins Div. 3
Boeing Airplane Co. 33
Continental Felt Co., Inc. 36
Copper & Brass Research Assoc. .. 18-19
Electrosnap Corp. ..... 4th Cover
Federated Metals Div., American Smelting & Refining Co. 24
Fluidwick Co. 36
Keuffel & Esser Co. 29
Link-Belt Co. 4
Microbeads, Inc. 34
Molded Fiber Glass Body Co. 32

PRODUCT ENGINEERING ADVERTISING SALES STAFF

Atlanta 3 . . . M. H. Miller, 1301 Rhodes-Haverty Bldg., Jackson 3-6951

Boston 16 . . . M. A. Williamson, Jr., 350 Park Square Bldg., Hubbard 2-7160

Chicago 11 . . . Mid-Western Adv. Sales Manager, A. E. Meanor; R. W. Bruley, L. Anderson, 520 N. Michigan Ave., Mohawk 4-5800

Cleveland 13 . . . A. F. Tischer, 1164 Illuminating Bldg., 55 Public Square, Superior 1-7000

Dallas 1 . . . R. T. Wood, 901 Vaughn Bldg., 1712 Commerce St., Riverside 7-5117

Denver 2 . . . John W. Patten, 1740 Broadway, Mile High Center, Alpine 5-2981

Detroit 26 . . . P. B. Robinson, 856 Penobscot Bldg., Woodward 2-1793

Los Angeles 17 . . . Robert Obenour, 1125 West 6th St., Madison 6-9351

New York 36 . . . B. K. Adams, J. C. Taney, R. G. Wallace, 500 Fifth Ave., Oxford 5-5959

Philadelphia 3 . . . D. G. Jones, K. S. Willadson, 6 Penn Center Plaza, Locust 8-4330

Pittsburgh 22 . . . C. F. Leveroni, 1111 Oliver Bldg., Express 1-1314

St. Louis 8 . . . R. W. Bruley, 3615 Olive St., Continental Bldg., Jefferson 5-4867

San Francisco 4 . . . W. C. Woolston, 68 Post St., Douglas 2-4600

NEW LITERATURE

The New Landscape

GYORGY KEPES, Professor of Visual Design, MIT. Paul Theobald & Co, 5 N Wabash Ave, Chicago 2. 384 pp, 8½ x 11, $15.50.

This book juxtaposes written and graphic depictions of the natural and man-made phenomena around us, drawn from the work of artists, scientists and engineers. Building, paintings, sculpture, drawings, pottery and photographs are shown, together with oscilloscope patterns and images from mathematics, microscopy, radiography, electronics. Beauty is evident in all, but the hints that the term "art" may be applicable to visual manifestations of scientific and engineering experimentation is, at best, left unproved. Too often the results are "emotional puns," as one contributor, Norbert Wiener says.

Yet this book should prove rewarding for those readers who must share responsibility for developmental work with such specialists as scientific personnel and industrial designers. Everyone can enjoy the book's 452 illustrations (some in color), both for the imagination manifest in their selection and the artistry of their arrangement.

There is every reason to believe that art and science can develop a common language, as well as a basis for creative work—practitioners common to these two fields were prevalent throughout Europe during the Renaissance, for example. *The New Landscape* can be credited with a good try. But a successful re-bridging of the gap probably must await men or women motivated by the living realities and needs of the political and economic crises permeating modern civilization. Too often Kepes and his contributors seem preoccupied with the intellectual exercise their subject affords. JK

ASME Annual Meeting (Nov 30-Dec 5)

—The Engineer as Administrator
—Human-factors Engineering

Among papers included in the panel discussion on the engineer in administration was one entitled, "Why More Engineers Are Not Considered for Administrative Positions" (ASME paper 58-A-163, V. D. Schoeller, Remington Rand Div, Sperry Rand Corp). Discusses "administrator" as man responsible for other corporate functions besides engineering and/or production.

"Developing from an Engineer to an Administrator" (D. J. Sizelove, Newark College of Engineering, ASME paper 58-A-240) tells how "hit-or-miss" methods of appraising administrative potential of engineers keeps many of them from getting such jobs. A two-stage procedure for analysis of this potential is described.

A number of papers were devoted to techniques used in developing man-machine systems. Among these contributions was, "Human Engineering Methods for System Development" (H. P. Van Cott, International Business Machines Corp, ASME paper 58-A-239). It discusses methods for integrating the engineering of a product with human factors.

"Data Collection for the Design and Evaluation of Man-machine Systems" (J. H. Ely, Dunlap & Associates Inc, ASME paper 58-A-241) discusses: (1) establishing system requirements; (2) selecting population; (3) simulated versus field measures; (4) repeating measurements; (5) objective versus subjective data; (6) sampling of data; (7) low-probability events; (8) special techniques for data collection.

COORDINATION IN ENGINEERING—Brochure, 8 pp. Arthur H Rau, General Electric Co, tells how good drafting programs achieve savings for both engineering and manufacturing. Filmsort Co, Div Michle-Goss-Dexter Inc, Pearl River, NY.

Circle 1, Reader Service Card

CAPABILITIES AND FACILITIES—Brochure, 36 pp. Covers departments of research and development, testing, production and other general information. Includes complete listing of capital equipment. Sundstrand Machine Tool Co, 10445 Glenoaks Blvd, Pacoima, Calif.

Circle 2, Reader Service Card

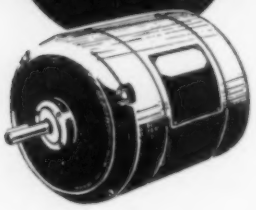
STORY OF THE SMALL SWITCH—Film, 16mm in color, with sound. Available on loan basis, without charge except return shipping charges. Running time, 38 min. Takes you through production facilities, testing procedures and applications. Shows how products are engineered and built. Exhibitions arranged. Micro Switch, Freeport, Ill.

Circle 3, Reader Service Card

MOLDING REINFORCED PLASTIC—Booklet, 8 pp. Describes material, shows applications, and gives properties and suggestions for design. Cincinnati Div, Cincinnati Milling Machine Co, Cincinnati 9.

Circle 4, Reader Service Card

Today-



better motors
are being built with

PERMAWICK

...the world's most
advanced sleeve
bearing lubricant

Write for
brochure...
5319 E. Outer Dr.
Detroit 34, Mich.

Fluidwick
COMPANY

CIRCLE 58 READER SERVICE CARD

FREE SAMPLES
and
APPLICATIONS
of INDUSTRIAL
FELT*

made to S.A.E.
and Federal
Govt.
Specifications

SEE
HOW
FELT
FITS IN
WITH YOUR
PRODUCTS

Ask for booklet

See why
CONTINENTAL
FELT
fills hundreds
of jobs daily

CONTINENTAL FELT COMPANY, INC. 1905
2228 WEST 15th STREET NEW YORK 11, N. Y.

Publisher's Postscript...

How to gamble on a sure thing

Look around you. In your engineering departments, in your research and product-development facilities, you'll find the breadboards, the prototypes, the almost-perfected new products of tomorrow. These departments can be your own built-in crystal ball—if you have the courage to look at them objectively—as well as your "passport to tomorrow."

This issue offers you a look into eight such crystal balls; eight companies seriously concerned with their tomorrows and willing to make substantial investments to back up their foresight. Though their products are very different—fasteners, rockets, office calculators, investment castings, pneumatics, adhesives, flight control, rubber products—their investment in R & D is uniformly high, higher than the national average by two or three times. And we'd guess their future is brighter than the national average, by two or three times.

The R & D facilities described here are by no means the newest, or the largest, or the most novel in the country. But they do exemplify an attitude toward engineers that is spreading through industrial management as a result of consumer attitudes toward the things they buy: That appearance alone, while important, is not enough. That function and consumer benefits, pure and simple, are a product's most important selling attributes. The user wants to know what a product can do, how long it can do it, and how easy it is to fix.

People (including you and me) don't like being manipulated by words or symbols. We have tasted some of the fruits of real research, honest innovation in miniaturized portable radios, better television sets, higher-fidelity records and components, synthetic fabrics—why should we settle for artificial innovations that cost as much, if not more?

Many of our industry leaders have learned the lesson—the others will be scrambling for the tail board very soon or be left permanently behind. —AH

For Your Information (personal)

Do-it-yourself solar kit

For those who have a serious interest in solar energy, Hoffman Electronics Corp is offering, "at cost," the solar energy kit pictured here. Developed primarily as a training and demonstration unit, it has four solar cells (silicon junction converters), a small electric motor, and a propeller that whirls when the unit is energized—either by sunlight or an incandescent bulb (150 watts or more). Price $14 "to qualified persons," from Hoffman, Dept K, 3761 S. Hill St. Los Angeles 7.

Less mess in the drafting room

Two devices for the engineering department use simple mechanisms to save time and effort. One is a new-type storage rack; the other, the paper roll-up pictured here.

The storage rack—for filing blueprints—is a rack-type unit with aluminum suspension arms. Made by Plan-Hold So, South Gate, Calif., it features a ball-and-socket clamp, tightened by a wing nut, that's said to grasp anywhere from 1 to 100 sheets, firmly yet without damage, and with no problems in removal (PE—Apr 28, '58, p 44).

The roll-up, called Rollo-Draft, is made by Aqua Sportsman, Cincinnati. It has a pawl and ratchet that hold the paper taut without tacks or tape and its own built-in paper cutter. The device, says its manufacturer, "makes it possible to shift the drawing, not the draftsman." A complete unit (including right- and left-hand subassemblies) for a 36-in. board is priced at $89.50; for a 42-in. board, at $96.50.

(Note: For other ideas on engineering department modernization, see Oct. 13 issue.)

(These are KEY numbers, not page numbers)

NEW LITERATURE Card expires 2/28/59

1 2 3 4 5 6 7 8 9 10

SIGNIFICANT PARTS

11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40

C—COVER

PRODUCTS ADVERTISED

51 52 53 54 55 56 57 58 59 60
61 62 63 64 65 66 67 68 69 70
71 72 73 74 75 76 77 78 79 80
C2 C3 C4

SPECIAL DATA _____

☐ *Enter my 1-year subscription of PRODUCT ENGINEERING. I will receive 52 weekly issues plus the annual Design Digest Issue. (Domestic—$5 for one year)*

PLEASE TYPE OR PRINT

Name .....
Title ..... Dept.....
Company .....
Address .....
City ..... Zone.... State.....12/29/58

★ *If you want to be sure of seeing every issue of Product Engineering—52 regular issues plus the annual Design Digest—enter your subscription on the attached information card. Only $5 for one year.*

(These are KEY numbers, not page numbers)

NEW LITERATURE Card expires 2/28/59

1 2 3 4 5 6 7 8 9 10

SIGNIFICANT PARTS

11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40

C—COVER

PRODUCTS ADVERTISED

51 52 53 54 55 56 57 58 59 60
61 62 63 64 65 66 67 68 69 70
71 72 73 74 75 76 77 78 79 80
C2 C3 C4

SPECIAL DATA _____

☐ *Enter my 1-year subscription of PRODUCT ENGINEERING. I will receive 52 weekly issues plus the annual Design Digest Issue. (Domestic—$5 for one year)*

PLEASE TYPE OR PRINT

Name .....
Title ..... Dept.....
Company .....
Address .....
City ..... Zone.... State.....12/29/58

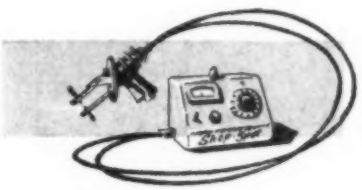
WHY DON'T THEY RESEARCH and DEVELOP. . .

. . . cleanser-impregnated, disposable (flushable) pads for cleaning washbowls, bath tubs, dishes, pots and pans or children's faces. A series of such pads with cleansers of varying harshness would eliminate the need for storing various soaps and powders plus a damp sponge or brush in bathroom or kitchen. —B Bonsal

. . . a warning light to indicate when brake fluid level is low. When the master cylinder level drops, brakes can suddenly become useless. This is a very dangerous situation—particularly on power-brake systems where pressures run relatively high and leakage is proportionately great. Most dashboards indicate when oil pressure is low or a generator is draining or charging—a brake fluid level indicator would be more to the point. —J T Allard

. . . an electromagnetic radiator (possibly in the visible light spectrum) which would condense fog into rain or heat it into invisible steam. Auto and street lights, lighthouses and landing-field flares would then do better than just reflect a bright fog curtain into a driver's eyes. —C Lisciani

. . . a small spot welder, about the size of a pair of pliers, for hobbyists, modelmakers, etc. —J A Gay



Have you a pet subject but neither the time nor inclination to do the necessary R & D? Product Engineering will welcome (and pay $10 each for) similar ideas based on known scientific principles but lacking an inspired manufacturer

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING
330 WEST 42ND STREET
NEW YORK 36, N. Y.

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

★ *If you want to be sure of seeing every issue of Product Engineering—52 regular issues plus the annual Design Digest—enter your subscription on the attached information card. Only $5 for one year.*

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING
330 WEST 42ND STREET
NEW YORK 36, N. Y.

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

DESIGN FREEDOM
STARTS WITH
ALCOA ALUMINUM

DOES YOUR DESIGN CALL FOR SCREW MACHINE PARTS?

Cut costs with ALCOA® Aluminum. It gives three times more parts per pound because it weighs only a third as much as steel or brass. Add aluminum's high scrap value . . . and you can save up to 30 per cent in material costs alone.

Light weight also adds design freedom. ALCOA Aluminum Screw Machine Stock helps you cure inertia problems without sacrificing strength or performance. Moving parts wear less because there's less resistance to applied force. Designers of automotive parts, business machines, ordnance, have proved it.

Aluminum offers exceptional machinability, limited almost entirely by machine capacity . . . high electrical and thermal conductivity . . . and choice of any finish, including lustrous, lasting anodized color.

Aluminum is versatile. Each of ALCOA's four screw machine stock alloys has significant advantages. Specify 2011-T3 for machinability; 6061-T6 for exceptional corrosion resistance and finishing characteristics; 2024-T4 for strength; and 2017-T4 for economy.

Argus, Johnson Motors, Leviton and other companies that switched to ALCOA Aluminum tell why in a booklet we've prepared. We'd like to send you a copy. Just mail the coupon.

ALCOA ALUMINUM

ALCOA THEATRE

Look for this label . . . it's your guide to the best in aluminum value

Aluminum Company of America
865-Z Alcoa Building, Pittsburgh 19, Pa.

Please send your new booklet about the switch to Alcoa Aluminum Screw Machine Stock.

Name _____

Position _____

Company _____

Address _____

City _____ Zone _____ State _____

NEW PUSH-BUTTON PANEL SWITCH

lights-up

in 3 colors...

FLUSH-PANEL MODEL, ACTUAL SIZE

Switch and three lights combined in a single modular unit use only 1 square inch of panel.

Monitors three different conditions with individual colors.

Reduces panel space requirements over 60%

Flush-panel or sub-panel mounting, side or bottom lamp terminals.

Bulbs quickly replaced from front of panel.

Switching is available in Alternate Action (push-on, push-off) or positive-feel Momentary. Other types of switching elements can be adapted to your application. Switches conform to military specifications. Lamp circuit may be wired independently, or through the switching unit. Lamps are quickly replaced from the front—no special tools required. Color filters available in combinations of any of six standard colors.

Write for new Technical Literature on TRILITE 3-color lighted pushbutton switches.

ELECTRO SNAP

ELECTROSNAP CORPORATION

SWITCH DIVISION

4246 West Lake Street, Chicago 24, Ill.
Telephone VAn Buren 6-3100 • TWX No. CG-1400

Switch Element
Alternate Action or positive feel Momentary Action available with double or triple pole switching units.
Lamp Termination
Easy to connect. Available with side or bottom terminals.
Lamp Module
Three lamps and color filters project monitoring signal on target screen. Removable as a unit from front of panel.
Actuator Yoke
Easily slides out for quick front-panel removal of lamp module.
Target Screen
Diffusing button insures even color distribution.
UNILITE...
Companion single-light pushbutton switch is also available.